GEORGIA INSTITUTE OF TECHNOLOGY
Engineering Experiment Station

PROJECT INITIATION

Date February 19, 1964

Project Title: Bibliography of Radar Reflection Characteristics

Project No.: A-755

Project Director: H. A. Corriher, Jr.

Sponsor: Department of the Army, U. S. Army Electronics Material Agency

Effective: 2-15-64 Estimated to run until: 9-14-65

Type agreement: Contract No. DA-36-039-AMC-03759(E)

Amount: $99,218.00 of which $50,000.00 has actually been allotted.

Reports: Monthly Letter-Type Reports - first due 3-20-64
Bibliography (3 Volumes)
2 Draft Copies with proposed distribution list due 10-15-65
350 Distribution Copies - due within 30 days after acceptance of the draft

Contact Person: U. S. Army Electronics Materiel Agency
Fort Monmouth Procurement Office
Fort Monmouth, New Jersey
Attn: Contracting Officer (for Admin. matters)

m

U. S. Army Electronics Research and Development Laboratory
Fort Monmouth, New Jersey
Attn: Mr. V. L. Friedrich or
Mr. J. Maresca (for Tech. matters)

Assigned to Radar Branch, Electronics Division

COPIES TO:

- [ ] Project Director
- [ ] Director
- [ ] Associate Director
- [ ] Assistant Director(s)
- [ ] Division Chiefs
- [ ] Branch Head
- [ ] General Office Services
- [ ] Rich Electronic Computer Center
- [ ] Engineering Design Services
- [ ] Technical Information Section
- [ ] Photographic Laboratory
- [ ] Shop
- [x] Security Officer
- [ ] Accounting
- [ ] Purchasing
- [ ] Report Section
- [ ] Library

GEORGIA INSTITUTE OF TECHNOLOGY
Engineering Experiment Station

PROJECT TERMINATION

Date January 11, 1968

PROJECT TITLE: Bibliography of Radar Reflection Characteristics

PROJECT NO: A-755

PROJECT DIRECTOR: H. A. Corriher, Jr.

SPONSOR: U. S. Army Electronics Material Agency, Fort Monmouth

TERMINATION EFFECTIVE: ~~Immediately~~

CHARGES SHOULD CLEAR ACCOUNTING BY: All charges have cleared

Elec.

Reports
300 . A-755

COPIES TO:

Project Director
Director
Associate Director
Assistant Directors
Division Chief
Branch Head
Accounting
Engineering Design Services

General Office Services
Photographic Laboratory
Purchasing
Report Section
Library
Security
Rich Electronic Computer Center

R + P Copy
PC

A-755

8/11/64

GEORGIA INSTITUTE OF TECHNOLOGY

ENGINEERING EXPERIMENT STATION
ATLANTA, GEORGIA 30332

16 June 1964

NOTICE
This document is not to be used by anyone.
Prior to 1-18 1970
without permission of the Research Sponsor and the Experiment Station Security Office.

Director, Radar Division
Surveillance Department
U. S. Army Electronics Research
and Development Laboratory
Fort Monmouth, New Jersey

Attention: Mr. V. L. Friedrich

Reference: Contract No. DA 36-039 AMC-03759(E)
Order No. 33040-PM-64-91

Title: Bibliography of Radar Reflection Characteristics

Subject: Monthly Letter Type Report No. 4
15 May 1964 through 14 June 1964

Dear Sir:

Major effort has been devoted during this reporting period to the identification and procurement of documents from DDC, and to setting up cross-indexing files. Thus far, some 2,000 documents have been ordered from DDC. Approximately 625 unclassified documents have now been received from DDC, and 584 classified documents; most of the latter were received in two large shipments late in this reporting period. All of the documents that were categorized as "to be ordered" in our initial screening of DDC abstract cards are now on order. Additional documents will continue to be ordered at a reduced rate, as they are located from review of the file of DDC abstract cards, from new cards received, from current issues of the Technical Abstract Bulletin (TAB), and from other sources.

DDC has not yet responded to our request for an additional machine search on a few subjects. We have also not received a response from the National Aeronautics and Space Administration to our request for a machine search of their holdings.

Routine procedures have been established for logging in of classified documents and abstract cards as they are received, and a special form has been printed for the document logbook. The log number assigned each document upon receipt will serve as primary identification of both the document and its abstract in routine handling during the life of the project as well as for purposes of security checks. For this reason, unclassified documents are being logged in, as well as classified ones.

Search of the Meteorological and Geoastrophysical Abstracts for 1957 through 1962 was largely finished, thereby substantially completing our initial search of the open literature. Most of the Xerox copies of abstracts have now been mounted on file cards for further review and checking against journal references in the reports being received.

Two hundred fifty copies of a hand-out sheet requesting assistance in identifying pertinent reflection reports were prepared for distribution at the Symposium on Radar Reflectivity Measurements held at Massachusetts Institute of Technology on 2 through 4 June. It is hoped that this solicitation will be especially helpful in obtaining reference to documents that are not in the DDC holdings.

While attending the 10th Annual Radar Symposium at Fort Monmouth on 26 through 28 May, Mr. H. A. Corriher, Jr. discussed progress of the project with Mr. C. R. Eason.

In the next interval, we will continue ordering documents from DDC, chiefly on the basis of references in the TAB's. We will also continue improving our cross-index files on reports ordered and received. When these files are available, it will be possible to look for apparent series of reports and identify missing ones for possible procurement.

Respectfully submitted,

fw H. A. Corriher, Jr.
Project Director, A-755

Approved:

for M. W. Long, Chief
Electronics Division

A-755

GEORGIA INSTITUTE OF TECHNOLOGY

ENGINEERING EXPERIMENT STATION

ATLANTA, GEORGIA 30332

17 July 1964

NOTICE

This document is not to be used by anyone.

Prior to 1-18 1970
without permission of the Research Sponsor and the Experiment Station Security Office

Director, Radar Division
Surveillance Department
U. S. Army Electronics Research
and Development Laboratory
Fort Monmouth, New Jersey

Attention: Mr. V. L. Friedrich

Reference: Contract No. DA 36-039 AMC-03759(E)
Order No. 33040-PM-64-91

Title: Bibliography of Radar Reflection Characteristics

Subject: Monthly Letter Type Report No. 5
15 June 1964 through 14 July 1964

Dear Sir:

During this fifth month of contract effort we have received nearly 1,000 documents from the Defense Documentation Center. As reported previously, other large shipments of documents arrived just prior to the beginning of this period so we have had a very heavy load of document processing for over a month. We have ordered about 2,400 documents from DDC and have received approximately 900 unclassified ones and 1,200 which are classified. Documents are now arriving in relatively small shipments which will be much easier to handle.

The information hand-out at the MIT Radar Reflectivity Symposium has produced seven responses so far, including comprehensive lists of pertinent reports from four major activities. A start has been made on cross-checking these lists against the DDC references and, although the percentage of pertinent documents in the DDC holdings which were not identified by their machine search is not large, a number of apparently significant additional references have been found. In addition, other reports in these lists are not in the DDC holdings because of their recent date or other reasons.

The supplementary machine searches from DDC have arrived in the form of 66 unclassified and 90 classified abstract cards. The NASA bibliography has been received and includes 515 unclassified references (including journals) and 104 classified ones. Several previous DDC bibliographies on related subjects have also been obtained.

The initial search for references to journal articles has been completed and covers the pertinent abstracting services for 1957 through 1962. About 850 references have been found for this six-year period.

It is now evident that our original estimates of 2,250 reports and 650 journal articles for the eight-year coverage of this bibliography are low. These estimates were based on coverage of the previous bibliography and the discrepancies appear to be the result of several factors. Missile and space programs have increased greatly since 1956 and, in addition, the radar reflection information associated therewith has gone to lower levels of security and sensitivity so that it is more generally available. Also, although the DDC holdings are not complete nor are their retrieval capabilities perfect (as discussed above), they are vastly improved over those available for the earlier bibliographies and relatively more references are being identified.

It is obvious that basic decisions on limitation of coverage will be required if this program is to be accomplished within its present budget and time estimates. We will study the problem as we get more complete document series and examine the material itself. When the situation is clearer, we plan to request a conference with USAELRDL personnel to discuss the problem. In the meantime, we will give certain of the missile and space information only minimum processing since this appears to be an area open to question for full abstracting for both technical and security reasons.

During the next interval we will continue tasks associated with document ordering and indexing which must be accomplished prior to abstracting if this major effort is to be performed efficiently.

Respectfully submitted,

H. A. Corriher, Jr.
Project Director, A-755

Approved:

for M. W. Long, Chief
Electronics Division

A-755

GEORGIA INSTITUTE OF TECHNOLOGY

ENGINEERING EXPERIMENT STATION
ATLANTA, GEORGIA 30332

17 August 1964

NOTICE
This document is not to be used by anyone.
Prior to 1-18 1970
without permission of the Research Sponsor and the Experiment Station Security Office.

Director, Radar Division
Surveillance Department
U. S. Army Electronics Research
and Development Laboratory
Fort Monmouth, New Jersey

Attention: Mr. V. L. Friedrich

Reference: Contract No. DA 36-039 AMC-03759(E)
Order No. 33040-PM-64-91

Title: Bibliography of Radar Reflection Characteristics

Subject: Monthly Letter Type Report No. 6
15 July 1964 through 14 August 1964

Dear Sir:

During this reporting interval we have continued ordering and indexing documents, and have cross checked our reference and order files and resolved the relatively few discrepancies which were found. We have now ordered over 2600 documents from DDC. Orders outstanding at this time total 361 documents, including 94 which have distribution limitations and for which USAELRDL has just been requested to provide justification for release approval by the controlling agencies.

Mr. William Bahret of the Air Force Avionics Laboratory, Wright-Patterson Air Force Base, Ohio, furnished the project director with a valuable bibliography of reports on radar reflection and absorbers during a visit by Mr. Corriher on other business.

Modification No. 1 to the contract has been received by the Georgia Tech Research Institute and allocates funds to complete the budgeted amount for this program.

During the next interval it is expected that the preliminary "bookkeeping" tasks will be sufficiently completed that we can begin abstracting and reference checking of the documents on hand. Expanded coverage of the journal literature is planned to cover translations of foreign journals and any cumulative abstract volumes which have arrived recently.

Respectfully submitted,

H. A. Corriher, Jr.
Project Director, A-755

Approved:

M. W. Long, Chief
Electronics Division

A-755

GEORGIA INSTITUTE OF TECHNOLOGY
ENGINEERING EXPERIMENT STATION
ATLANTA, GEORGIA 30332

18 September 1964

NOTICE

This document is not to be used by anyone.

Prior to 1-18 1970
without permission of the Research Sponsor and the Experiment Station Security Office.

Director, Radar Division
Surveillance Department
U. S. Army Electronics Research
and Development Laboratory
Fort Monmouth, New Jersey

Attention: Mr. V. L. Friedrich

Reference: Contract No. DA 36-039 AMC-03759(E)
Order No. 33040-PM-64-91

Title: Bibliography of Radar Reflection Characteristics

Subject: Monthly Letter Type Report No. 7
15 August 1964 through 14 September 1964

Dear Sir:

As of the end of this reporting interval, we have ordered almost 2800 documents from DDC, with about 225 still on order. Release approval has been requested through channels for 196 documents with distribution limitations but none of these has been received yet.

A new DDC Field-of-Interest Register (FOIR) on this contract has been forwarded through USAELRDL for approval. This is necessary because DDC occasionally categorizes documents according to one or two gross subject areas. For example, some documents in a series on radar absorbers will be placed only in the field of "non-metallic materials." We have reviewed the apparently pertinent references which were outside our original FOIR and have requested only those additional areas which seem to involve a significant number of documents.

In planning ahead for the eventual task of preparing a subject index for the bibliography, we are considering the possible use of an electronic computer. We have discussed the problem with personnel of our Rich Electronic Computer Center and have set up processing forms to be suitable for key punching if this appears worthwhile at the time the index is prepared.

Additional work in the journal literature has been accomplished. An abstract service for technical translations has been searched and cumulative indexes to two of the regular abstract services have become available and been searched. We now have approximately 1000 references to journal literature.

The subject matter has been reviewed for about 2300 DDC abstract cards on documents which have been ordered. Although recent documents are not well covered, it appears that approximately one-fourth of the titles fall in the general area of missile and space work. For recent years, this area constitutes about one-third or so of the references. Mr. Corriher plans to visit Ft. Monmouth on 21-22 September 1964 to discuss possible limitations on coverage of the present bibliography and to review material at the Technical Library.

Although we are not completely through with our "bookkeeping" tasks for the material in hand, we have begun abstracting. This effort should increase appreciably during the next reporting period.

Respectfully submitted,

H. A. Corriher, Jr.
Project Director, A-755

Approved:

M. W. Long, Chief
Electronics Division

A-755

GEORGIA INSTITUTE OF TECHNOLOGY

ENGINEERING EXPERIMENT STATION
ATLANTA, GEORGIA 30332

19 October 1964

NOTICE

This document is not to be used by anyone.

Prior to 1-18 1970
without permission of the Research Sponsor and the Experiment Station Security Office.

Director, Radar Division
Surveillance Department
U. S. Army Electronics Research and Development Laboratory
Fort Monmouth, New Jersey

Attention: Mr. V. L. Friedrich

Reference: Contract No. DA 36-039 AMC-03759(E)
Order No. 33040-PM-64-91

Title: Bibliography of Radar Reflection Characteristics

Subject: Monthly Letter Type Report No. 8
15 September 1964 through 14 October 1964

Dear Sir:

As of the end of this reporting period, we have ordered about 2900 documents from DDC, with approximately 250 still on order. Although a few documents with distribution limitations have been received, this category represents the majority of the outstanding orders. We have a backlog of orders which await notice of approval of the revised Field-of-Interest Register submitted last month.

During discussions at Fort Monmouth on 21-22 September 1964 between Dr. Leonard Hatkin and Mr. C. R. Eason of USAEL and Mr. H. A. Corriher, Jr. of Georgia Tech, it was decided that the present contract program should provide literature coverage according to the following priorities:

I. Unclassified and classified material on "conventional" topics

II. Unclassified material on "missile/space" topics

III. Confidential material on "missile/space" topics

IV. Secret material on "missile/space" topics

If material in Priority I exceeds the capabilities of the present contract budget and time, consideration will be given to reducing the eight-year coverage period.

Mr. Corriher discussed the problem of excluding the missile/space information with Mr. Morris Witow of ARPA on 24 September 1964, and was informed that ARPA had a general interest in coverage of these subject areas as well as in a continuing radar reflectivity bibliography program. Mr. Witow is investigating the funding situation but no decision on the matter had been made as of the end of this reporting period. It is hoped that ARPA will be able to support this effort to provide more complete coverage of the literature.

Review of the report files at the USAEL Technical Library on 22 September 1964 was disappointing in that only a few pertinent reports were found. As is probably the case in most agencies, reliance is placed on the Defense Documentation Center for general reference services and most technical reports are kept only at the technical working level. Mr. Eason will provide the project with a list of certain reports available in his office, and Dr. Hatkin will arrange for our getting reports on initial distribution from pertinent USAEL contracts.

Mr. Peter Fritsch of the MIT Lincoln Laboratory has informed Mr. Corriher that an entire issue of the Proceedings of the IEEE will be devoted to radar reflectivity in the late summer of 1965. Basic agreement has been reached between Georgia Tech and USAEL to provide Mr. Fritsch with an unclassified bibliography on the subject for inclusion in this issue; however, details of subject coverage and amount of material have not been settled. It is likely that the contract program will produce appreciable material that cannot be given the wide distribution of the journal article because of subject matter and space limitations.

During the next report interval we will continue our efforts of ordering, processing, and abstracting reports.

Respectfully submitted,

H. A. Corriher, Jr.
Project Director, A-755

Approved:

M. W. Long, Chief
Electronics Division

A-755

GEORGIA INSTITUTE OF TECHNOLOGY

ENGINEERING EXPERIMENT STATION

ATLANTA, GEORGIA 30332

18 November 1964

NOTICE

This document is not to be used by anyone.

Prior to 1-18 1970

without permission of the Research Sponsor and the Experiment Station Security Office.

Director, Radar Division
Surveillance Department
U. S. Army Electronics Laboratories
Fort Monmouth, New Jersey

Attention: Mr. V. L. Friedrich

Reference: Contract No. DA 36-039 AMC-03759(E)
Order No. 33040-PM-64-91

Title: Bibliography of Radar Reflection Characteristics

Subject: Monthly Letter Type Report No. 9
15 October 1964 through 14 November 1964

Dear Sir:

We have now received 2,624 documents for processing on this contract and have 216 currently on order from DDC. The revised Field-of-Interest Register has been received, enabling 82 of these documents to be ordered. Many of the 196 limited distribution documents which were requested in August have now been received. We have been informed by USAEL that, of the remainder, one document contains no pertinent information, release approval has been refused on another, and approval on 57 others is in doubt and will require further contact with the Advanced Research Projects Agency (ARPA).

Mr. H. A. Corriher, Jr. visited Mr. Morris I. Witow of ARPA on 3 November 1964 to discuss extending the coverage of the bibliography to include "missile/space" topics likely to be excluded from the present effort according to the priorities outlined in the previous progress letter. Mr. Witow indicated that ARPA will fund additional work to include this material and will probably accomplish this by an ARPA Order through USAEL contract channels. Georgia Tech will submit a proposal on this program as soon as details of content of additional volumes, number of copies, etc. have been settled. We expect the increased coverage to require about six months of additional effort and will contact USAEL personnel to discuss interrelationships with the current program as soon as ARPA requirements are firm.

Dr. John Rheinstein of MIT Lincoln Laboratory visited Atlanta on 27 October to discuss our furnishing an unclassified bibliography for the IEEE special publication on radar reflectivity mentioned in the previous progress letter. It appears that limitations on the number of pages will require a bibliography of titles only. Lincoln Laboratory will contact us when the topics of the papers have been selected, and we will, in general, provide bibliographic coverage only on the topics of the papers. Dr. Rheinstein briefly reviewed our file of open literature references and expressed the opinion that these and the unclassified report references would be a valuable contribution to the special issue of the Proceedings of the IEEE.

We have received a list of technical documents on radar reflectivity which are available at USAEL. Of the 146 different items listed, we had previous knowledge of 123. The remaining references will be reviewed and pertinent documents obtained from DDC or examined at USAEL.

Our efforts of ordering, processing, and abstracting reports will be continued during the next report period.

Respectfully submitted,

H. A. Corriher, Jr.
Project Director, A-755

Approved:

M. W. Long, Chief
Electronics Division

A-155

GEORGIA INSTITUTE OF TECHNOLOGY
ENGINEERING EXPERIMENT STATION
ATLANTA, GEORGIA 30332

18 December 1964

NOTICE
This document is not to be used by anyone,
Prior to 1-18 1970
without permission of the Research Sponsor
and the Experiment Station Security Office.

Director, Radar Division
Surveillance Department
U. S. Army Electronics Laboratories
Fort Monmouth, New Jersey

Attention: Mr. V. L. Friedrich

Reference: Contract No. DA 36-039 AMC-03759(E)
Order No. 33040-PM-64-91

Title: Bibliography of Radar Reflection Characteristics

Subject: Monthly Letter Type Report No. 10
15 November 1964 through 14 December 1964

Dear Sir:

As of the end of this reporting period, we have ordered about 3000 documents from DDC with approximately 200 still on order. Of the 196 limited distribution documents which were requested in August, 69 are still in an active-order status, 57 will require further discussions with the Advanced Research Projects Agency (ARPA), and the remainder have either been received or the orders cancelled.

A cross-reference file of contracts has been prepared to allow identification of reports when the contract number is known and to summarize the report series on each contract. We have found references to 767 separate contracts and an additional 172 non-contract sources (U.S., British, and Canadian government laboratories, etc.).

The additional effort necessary to extend the bibliographic coverage to include "missile/space" topics is set forth in a proposal now being prepared for submission to ARPA. This proposal provides for extending the coverage from 2250 reports and 650 journal articles to 3250 reports and 1000 journal articles, with 500 copies of a four-volume bibliography to be submitted instead of 350 copies of a three-volume set as presently required. We are making this proposal on the basis that the additional work would be handled contractually as a modification to the present contract. The proposal to ARPA has been discussed with Dr. Leonard Hatkin of USAEL, and a copy will be furnished to Mr. Charles R. Eason when it is submitted to ARPA.

Our efforts of ordering, processing, and abstracting reports will be continued during the next report period.

Respectfully submitted,

H. A. Corriher, Jr.
Project Director, A-755

Approved:

M. W. Long, Chief
Electronics Division

GEORGIA INSTITUTE OF TECHNOLOGY
ENGINEERING EXPERIMENT STATION
ATLANTA, GEORGIA 30332

A-755

18 January 1965

Director, Radar Division
Surveillance Department
U. S. Army Electronics Laboratories
Fort Monmouth, New Jersey

Attention: Mr. V. L. Friedrich

Reference: Contract No. DA 36-039 AMC-03759(E)
Order No. 33040-PM-64-91

Title: Bibliography of Radar Reflection Characteristics

Subject: Monthly Letter Type Report No. 11
15 December 1964 through 14 January 1965

Dear Sir:

As of the end of this reporting period, we have processed 3,211 report references which are apparently pertinent to the subject matter of the bibliography. These references are in the following categories:

Documents received by project	2,874
Documents otherwise available	60
Active orders (limited distribution)	67
Active orders (unlimited distribution)	62
Inactive orders (not at DDC, release disapproved, etc.)	148
TOTAL REFERENCES	3,211

We have now acquired or otherwise processed nearly 50% more report references than the 2250 originally anticipated. This has caused us to be somewhat behind on our abstracting effort since, sometime ago, we made the basic decision not to do extensive actual abstracting until the document collection was reasonably complete. Fairly complete report series are now available for many contracts, and we are substantially increasing the abstracting effort in order to get back on our original schedule.

As discussed in the previous monthly progress letter, we are asking the Advanced Research Projects Agency (ARPA) to fund an increased effort on this program to allow us to include abstracts on missile/space topics. An unsolicited proposal, dated 18 December 1964, has now been sent to ARPA, with a copy to Mr. Charles R. Eason of USAEL.

During this past month we have reviewed the alphabetical subject index used for the previous radar reflection bibliography issued in 1958 under Contract DA 36-039 SC-73133, and decided that many modifications were necessary to reflect changes in literature composition and usage of terms since then. Therefore, we have drafted an extensively revised subject index and are now reviewing this for use as an interim index for abstractors. The index will continue to be changed as abstractors develop the need for additional subject headings.

During the next reporting period we will continue the functions of processing references and abstracting. On 22 January 1965 the Project Director expects to visit the Battelle-DEFENDER project at Battelle Memorial Institute, Columbus, Ohio, to examine the files of this information analysis center to determine their pertinence to the radar reflection bibliography.

Respectfully submitted,

H. A. Corriher, Jr.
Project Director, A-755

Approved:

M. W. Long, Chief
Electronics Division

H-755

GEORGIA INSTITUTE OF TECHNOLOGY

ENGINEERING EXPERIMENT STATION
ATLANTA, GEORGIA 30332

19 February 1965

NOTICE

This document is not to be used by anyone. Prior to 1-18 1970 without permission of the Research Sponsor and the Experiment Station Security Office.

Director, Radar Division
Surveillance Department
U. S. Army Electronics Laboratories
Fort Monmouth, New Jersey

Attention: Mr. V. L. Friedrich

Reference: Contract No. DA 36-039 AMC-03759(E)
Order No. 33040-PM-64-91

Title: Bibliography of Radar Reflection Characteristics

Subject: Monthly Letter Type Report No. 12
15 January 1965 through 14 February 1965

Dear Sir:

At the end of one year of contract effort, we have processed approximately 3300 report references. Nearly 3000 reports have been received, another 60 documents are otherwise available, about 80 are on order from DDC, and 160 are in inactive-order status. During this last month we received a number of limited-distribution reports from DDC which have been on order since last August.

Permission has been requested from USAEL for us to publish a selected bibliography of journal-article titles in the forthcoming special issue on radar reflectivity of the Proceedings of the IEEE described in previous letter reports. Under the assumption that this permission will be granted, we have increased our effort in searching the open literature in order to meet the publication deadline.

On 21-22 January 1965, the Project Director visited information centers at the Air Force Avionics Laboratory, Wright-Patterson AFB, Ohio, and Battelle Memorial Institute, Columbus, Ohio. Although these centers are mission oriented, they contain considerable information pertinent to this bibliography. We have requested USAEL to arrange need-to-know for project personnel to visit these centers and check their holdings for references.

Abstractors are now being assigned blocks of reports in specific subject areas, and we have made substantial progress in abstracting the relatively large number of reports containing chaff information. We have arranged for several additional persons to abstract during the next few months in order to get this aspect of our work back on schedule.

Our efforts of ordering, processing, and abstracting reports will be continued during the next report period.

Respectfully submitted,

H. A. Corriher, Jr.
Project Director, A-755

Approved:

M. W. Long, Chief
Electronics Division

A-755

GEORGIA INSTITUTE OF TECHNOLOGY

ENGINEERING EXPERIMENT STATION
ATLANTA, GEORGIA 30332

19 March 1965

NOTICE
This document is not to be used by anyone
Prior to 1-18 1970
without permission of the Research Sponsor
and the Experiment Station Security Office.

Director, Radar Division
Surveillance Department
U. S. Army Electronics Laboratories
Fort Monmouth, New Jersey

Attention: Mr. V. L. Friedrich

Reference: Contract No. DA 36-039 AMC-03759(E)
Order No. 33040-PM-64-91

Title: Bibliography of Radar Reflection Characteristics

Subject: Monthly Letter Type Report No. 13
15 February 1965 through 14 March 1965

Dear Sir:

As of the end of this reporting period, we have received nearly 3050 documents and have about 120 on order from DDC. Approximately 80 are otherwise available for project use, and 160 references have been placed in inactive-order status.

USAEL has granted us permission to publish a selected bibliography of journal-article titles and we are now completing the search for this material. The published bibliography will have somewhat narrower coverage that that to be issued under the contract program, and we expect to publish 1000 to 1200 references covering the time period 1957-1964.

Our requests for USAEL to establish need-to-know for us at two activities have been acted on promptly. We have received a set of "Battelle-DEFENDER Annotated Accession Lists" which Battelle Memorial Institute issues. Also, correspondence from Recon Central at the Air Force Avionics Laboratory indicates that need-to-know has been established and that we may use their services and request a machine search of their files. When reference material now available to us in Atlanta has been cross checked against our files, we plan to visit these information centers to fill gaps in our coverage.

We have increased our abstracting effort substantially during the last month. Primary effort is being given to aircraft, anti-radar coatings, measurement techniques and equipment, diffraction theory, weather, and terrain.

REVIEW
PATENT 3-24 1965 BY.
FORMAT 3-24 1965 BY.

Our work during the next report period will be devoted to processing references and abstracting reports.

Respectfully submitted,

H. A. Corriher, Jr.
Project Director, A-755

Approved:

M. W. Long, Chief
Electronics Division

GEORGIA INSTITUTE OF TECHNOLOGY
ENGINEERING EXPERIMENT STATION
ATLANTA, GEORGIA 30332

A-755

16 April 1965

NOTICE
This document is not to be used by anyone
Prior to 1-18 1970
without permission of the Research Sponsor
and the Experiment Station Security Office

Director, Radar Division
Surveillance Department
U. S. Army Electronics Laboratories
Fort Monmouth, New Jersey

Attention: Mr. V. L. Friedrich

Reference: Contract No. DA 36-039 AMC-03759(E)
Order No. 33040-PM-64-91

Title: Bibliography of Radar Reflection Characteristics

Subject: Monthly Letter Type Report No. 14
15 March 1965 through 14 April 1965

Dear Sir:

We have now received approximately 3080 documents from DDC and have an additional 110 on order. About 100 reports are otherwise available for project use, and 160 references are in inactive-order status.

During this reporting period we have completed the search of open literature for the bibliography of titles to be published in the Proceedings of the IEEE and approximately 1400 references will be submitted to the editors. Additional items to be included in the bibliography of the contract program will probably raise the total to about 1700 for this purpose.

On 21-22 April 1965 the project director will visit Redstone Arsenal, Alabama, and has requested need-to-know from USAEL to discuss radar reflectivity information with several of the U.S. Army Missile Command offices. The purpose of these initial discussions will be to determine the type of information available and its suitability for the bibliography.

Request for Quotation No. AMC(E) 28-043-65-00514(N) has been received from the Fort Monmouth Procurement Division and relates to additional effort under the subject contract. We will submit a proposal for this work in accordance with our previous unsolicited proposal to ARPA dated 18 December 1964 and discussed in Monthly Letter Type Reports Nos. 10 and 11.

REVIEW
PATENT 10-14 1965 BY
FORMAT 10-14 1965 BY

Our abstracting effort remains at its increased level and will continue during the next report period. Routine processing functions will also be performed.

Respectfully submitted,

H. A. Corriher, Jr.
Project Director, A-755

Approved:

for M. W. Long, Chief
Electronics Division

A-755

GEORGIA INSTITUTE OF TECHNOLOGY

ENGINEERING EXPERIMENT STATION

ATLANTA, GEORGIA 30332

18 May 1965

NOTICE

This document is not to be used by anyone.

Prior to 1-18 1970
without permission of the Research Sponsor
and the Experiment Station Security Office.

Director, Radar Division
Surveillance Department
U. S. Army Electronics Laboratories
Fort Monmouth, New Jersey

Attention: Mr. V. L. Friedrich

Reference: Contract No. DA 36-039 AMC-03759(E)
Order No. 33040-PM-64-91

Title: Bibliography of Radar Reflection Characteristics

Subject: Monthly Letter Type Report No. 15
15 April 1965 through 14 May 1965

Dear Sir:

As of the end of this reporting period, we have received nearly 3125 documents and have about 130 on order from DDC. About 110 reports are otherwise available for project use, and over 160 have been placed in inactive-order status because of release limitations or other reasons for non-availability from DDC.

We have completed the bibliography of open literature to be published in the August issue of the Proceedings of the IEEE. This bibliography consists of 1420 references from over 275 journals or other publications and represents contributions from over 1225 authors. The bibliography has broad subject coverage for the years 1957-1964 and includes a very large number of papers published in foreign journals. As soon as they are reproduced, manuscript copies of the bibliography will be provided technical personnel at USAEL.

Work on the open-literature bibliography has given us a basic author index and categorization of references by broad subject categories which will be useful when this material is prepared for the contract bibliography. Although the open-literature search will continue, this aspect of our effort will now have low priority.

On 21-22 April 1965 the project director visited Redstone Arsenal, Alabama, on other business and while there contacted the Redstone Scientific Information Center (RSIC). RSIC has a number of pertinent holdings which are not available from DDC, particularly those generated by U. S. Army Missile Command and NASA programs. It is planned to visit this activity later to further review their files.

Modification No. 3 to the referenced contract has been received, signed, and returned to Fort Monmouth. This modification adds six months and $39,513 to the present contract to allow additional material to be covered and a fourth volume of abstracts to be issued.

We have now reduced the abstracting effort in some subject areas, but good progress is being made on an overall basis. Our efforts on processing references and abstracting material will continue during the next reporting period.

Respectfully submitted,

H. A. Corriher, Jr.
Project Director, A-755

Approved:

M. W. Long, Chief
Electronics Division

A-755

GEORGIA INSTITUTE OF TECHNOLOGY
ENGINEERING EXPERIMENT STATION
ATLANTA, GEORGIA 30332

18 October 1965

Director, Radar Division
Surveillance Department
U. S. Army Electronics Laboratories
Fort Monmouth, New Jersey 07703

Attention: Mr. V. L. Friedrich

Reference: Contract No. DA 36-039 AMC-03759(E)
Order No. 33040-PM-64-91

Title: Bibliography of Radar Reflection Characteristics

Subject: Monthly Letter Type Report No. 20
15 September 1965 through 14 October 1965

Dear Sir:

We have now processed a total of 3583 references for the bibliography. Of these, 3340 are documents available for abstracting, 91 are active orders to the Defense Documentation Center (DDC), and 152 are inactive orders. The majority of the outstanding orders to DDC are for limited-distribution documents.

Although our effort on abstracting was sharply increased during this reporting period, we remain behind on this aspect of our work. It now appears that it will be necessary to request a change in delivery date for at least the first three volumes of the bibliography, if not all four. The situation will be reviewed during the next reporting period, and a request for extension of time will be initiated through the proper channels.

The majority of the persons who were requested to review our subject index have now replied with some very helpful suggestions. Our further work on indexing journal articles and on abstracting reports has indicated other desirable changes to the index. We will probably make another revision during the next reporting interval.

Our work on indexing journal articles has gone very well and we are almost finished with those now available. The clean-up search for additional open-literature references has begun as a low-level effort.

We have generated a card file of authors in anticipation of later indexing needs. This file contains approximately 3000 names, or about 1.2 references per author. This is almost identical to the finding for the open literature which had previously given us about 1250 authors for 1420 references. It was noticed that most of the additional names were authors of classified material, and that a high percentage of the unclassified reports had authors who were already in the file from the open-literature work.

During the next report period we will continue our efforts of processing references, abstracting, and editing. It is planned that project personnel will visit the Air Force Avionics Laboratory and Battelle Memorial Institute November 8th through 12th for the purpose of screening references at Recon Central and Battelle-DEFENDER, respectively.

Respectfully submitted,

H. A. Corriher, Jr.
Project Director, A-755

Approved:

M. W. Long, Chief
Electronics Division

A-755

GEORGIA INSTITUTE OF TECHNOLOGY

ENGINEERING EXPERIMENT STATION

ATLANTA, GEORGIA 30332

19 November 1965

NOTICE

This document is not to be used by anyone.

Prior to 1-18 1970 without permission of the Research Sponsor and the Experiment Station Security Office.

U. S. Army Electronics Command
ATT: Dr. Leonard Hatkin
AMSEL-HL-R
Fort Monmouth, New Jersey 07703

Reference: Contract No. DA 36-039 AMC-03759(E)
Order No. 33040-PM-64-91

Title: Bibliography of Radar Reflection Characteristics

Subject: Monthly Letter Type Report No. 21
15 October 1965 through 14 November 1965

Dear Sir:

As of the end of this reporting period, we have processed a total of 3604 references. Of these, 3391 are documents available for abstracting, 60 are active orders to the Defense Documentation Center, and 153 are inactive orders. Limited distribution documents still comprise the majority of the outstanding orders although a substantial number in this category have come in this month.

Our subject index has been revised and is being used to check the index terms applied to the journal articles available at this time. When this work is completed, we will begin computer programming and key punching for processing the index.

The project director and Mr. Berry O. Pyron visited the Battelle-Defender Information Analysis Center at Battelle Memorial Institute 9-12 November and reviewed the "extract" cards on their holdings of approximately 10,000 documents related to ballistic-missile defense. We located approximately 500 new references which are potentially pertinent to the bibliography. Copies of these cards will be forwarded to USAEL for further transmittal to this project; when they arrive we will consider them more carefully for possible inclusion. We will probably base our treatment on the Battelle extracts and will order full documents only in exceptional cases. The addition of this material should make the bibliography more valuable to users engaged in missile and space research.

The project director visited Recon Central at the Air Force Avionics Laboratory on 8 November and obtained a list of approximately 1000 titles for further screening. Preliminary examination of this list indicates that most of the pertinent references are already in our system but that it will probably be desirable for a hundred or so abstract cards to be requested from Recon Central for further screening. Again, we will probably order only a few full documents from this list.

During the next reporting period we will continue our efforts of processing references, abstracting, and editing. We remain behind schedule on the abstracting effort and will make a formal request for a change in delivery date during this next period.

Respectfully submitted,

H. A. Corriher, Jr.
Project Director, A-755

Approved:

M. W. Long, Chief
Electronics Division

A-755

GEORGIA INSTITUTE OF TECHNOLOGY

ENGINEERING EXPERIMENT STATION

ATLANTA, GEORGIA 30332

17 December 1965

NOTICE

This document is not to be used by anyone.

Prior to 1-18 1970
without permission of the Research Sponsor and the Experiment Station Security Office.

U. S. Army Electronics Command
Attention: Dr. Leonard Hatkin
AMSEL-HL-R
Fort Monmouth, New Jersey 07703

Reference: Contract No. DA 36-039 AMC-03759(E)
Order No. 33040-PM-64-91

Title: Bibliography of Radar Reflection Characteristics

Subject: Monthly Letter Type Report No. 22
15 November 1965 through 14 December 1965

Gentlemen:

As of the end of this reporting period, we have processed a total of 3979 references. Of these, 3404 are documents available for abstracting, 365 are abstracts from other sources, 55 are active orders to the Defense Documentation Center, and 155 are inactive orders. The 365 abstracts listed above were obtained from our search at the Battelle-Defender Information Analysis Center. We have not finished processing the list of potential references obtained recently from Recon Central.

Our current estimate is that references to about 4000 reports and 1500 journal articles will be included in the bibliography. This represents an additional 750 reports and 500 journal articles over the estimate used in increasing the scope of work under Modification No. 3 to the referenced contract. Although we do not at this time anticipate the need for additional funds, we have requested two additional months for the performance of the contract effort. Also, instead of issuing three volumes of abstracts and then a fourth one three months later, we have requested that delivery of the entire four-volume set be made at the same time.

During the next reporting period, we will continue our efforts of processing references, abstracting, and editing.

Respectfully submitted,

H. A. Corriher, Jr.
Project Director, A-755

Approved:

M. W. Long, Chief
Electronics Division

A-755

GEORGIA INSTITUTE OF TECHNOLOGY

ENGINEERING EXPERIMENT STATION

ATLANTA, GEORGIA 30332

18 January 1966

U. S. Army Electronics Command
Attention: Dr. Leonard Hatkin
AMSEL-HL-R
Fort Monmouth, New Jersey 07703

Reference: Contract No. DA 36-039 AMC-03759(E)
Order No. 33040-PM-64-91

Title: Bibliography of Radar Reflection Characteristics

Subject: Monthly Letter Type Report No. 23
15 December 1965 through 14 January 1966

Gentlemen:

We have processed a total of 3986 references as of the end of this reporting period. Of these, 3417 are documents available for abstracting, 365 are abstracts from other sources, 49 are active orders, and 155 are inactive orders. The list of potential references obtained from Recon Central has been screened, and 199 abstracts requested for further review and possible inclusion in the bibliography. We have also reviewed issues of Science Abstracts dated through June 1965 and have a number of additional references to journal articles and other open literature.

Instructions have been received for marking the bibliography volumes to give credit to the Advanced Research Project Agency for their support of this program. Although we do not yet have approval for the extension of time without additional funds requested during the last report interval, we are proceeding on the basis that approval will be granted.

During the next reporting period, we will continue our efforts of processing references, abstracting, and editing.

Respectfully submitted,

H. A. Corriher, Jr.
Project Director, A-755

A-755

GEORGIA INSTITUTE OF TECHNOLOGY

ENGINEERING EXPERIMENT STATION

ATLANTA, GEORGIA 30332

16 February 1966

NOTICE

This document is not to be used by anyone.

Prior to ~~2-16~~ 1-18 19~~69~~ 70

U. S. Army Electronics Command
Attention: Dr. Leonard Hatkin
AMSEL-HL-R
Fort Monmouth, New Jersey 07703

Reference: Contract No. DA 36-039 AMC-03759(E)
Order No. 33040-PM-64-91

Title: Bibliography of Radar Reflection Characteristics

Subject: Monthly Letter Type Report No. 24
15 January 1966 through 14 February 1966

Gentlemen:

We have processed a total of 3986 references as of the end of this reporting period. Of these, 3428 are documents available for abstracting, 365 are abstracts from other sources, 38 are active orders, and 155 are inactive orders. The abstracts requested from Recon Central have been received and will be screened for inclusion of pertinent material in the bibliography. This should add about one hundred references to the total.

Several computer searches requested from DDC at the end of December have been received. This material will allow coverage of one hundred major contract series to be checked, as well as specific subject areas. We do not plan to make any more sizable orders to DDC, and will use their abstracts for listing most references that are located from now until the end of the contract.

During the next reporting period, we will continue our efforts of processing references, abstracting, and editing.

Respectfully submitted,

H. A. Corriher, Jr.
Project Director, A-755

REVIEW

PATENT 2-10 19 67 BY

FORMAT 2-10 19 67 BY

A-755

GEORGIA INSTITUTE OF TECHNOLOGY

ENGINEERING EXPERIMENT STATION

ATLANTA, GEORGIA 30332

18 March 1966

NOTICE

This document is not to be used by anyone

1-18 19 70

U. S. Army Electronics Command
Attention: Dr. Leonard Hatkin
AMSEL-HL-R
Fort Monmouth, New Jersey 07703

Reference: Contract No. DA 36-039 AMC-03759(E)
Order No. 33040-PM-64-91

Title: Bibliography of Radar Reflection Characteristics

Subject: Monthly Letter Type Report No. 25
15 February 1966 through 14 March 1966

Gentlemen:

The status of the various categories of report references has not changed substantially since the last reporting period. We are now consolidating references and abstracts from several sources, and are eliminating duplications which would be included in individual totals of the various classes of references.

It is estimated that we have approximately 3950 unique report references, with over 3400 of these represented by documents available for abstracting and 550 being abstracts or citations from other sources such as Defense Documentation Center, Battelle-Defender, and Recon Central. We have virtually completed our work with the open literature and have a total of about 1650 references. These report and journal totals are considerably in excess of those contemplated when the scope of work was increased under Modification No. 3 to the subject contract.

During the next reporting period, we will continue our efforts of processing references, abstracting, and editing. We remain behind schedule and are attempting to catch up in order to meet the requested delayed delivery date discussed in Monthly Letter Type Report No. 22.

Respectfully submitted,

H. A. Corriher, Jr.
Project Director, A-755

REVIEW

PATENT 2-10 1967 BY

FORMAT 2-10 1967 BY

A-7??

GEORGIA INSTITUTE OF TECHNOLOGY

ENGINEERING EXPERIMENT STATION

ATLANTA, GEORGIA 30332

18 April 1966

U. S. Army Electronics Command
Attention: Dr. Leonard Hatkin
AMSEL-HL-R
Fort Monmouth, New Jersey 07703

Reference: Contract No. DA 36-039 AMC-03759(E)
Order No. 33040-PM-64-91

Title: Bibliography of Radar Reflection Characteristics

Subject: Monthly Letter Type Report No. 26
15 March 1966 through 14 April 1966

Gentlemen:

The status of the various categories of references has not changed substantially since that reported in Monthly Letter Type Report No. 24. We are now developing the list of approximately 375 source agencies and sorting references according to contract number, report number, etc. within each agency in the manner that will be used in the bibliography volumes.

Except for final cleanup, abstracts of unclassified material are complete and we will soon have these abstracts ready for final typing. The unclassified volume will be the largest of the four, and will contain abstracts of about 1300 reports, and titles of about 1650 journal articles. The subject and author indexes are also planned for this volume.

We have considered the problem of preparing the subject index and believe that use of the computer is not appropriate. Although we had originally contemplated using the computer for sorting, there have been such severe evolutionary changes in index terms that the problem of converting old terms to new ones seems best solved by manual operation. There is still, however, a possibility of mechanizing for final computer printout of the terms.

Modification No. 4 to the subject contract has been received and changes the delivery dates for all four bibliography volumes to 15 June 1966. We remain behind in performing the numerous serial operations necessary to complete the bibliography, and may find it necessary to request a further delay in delivery. Funds remaining appear to be adequate unless unforeseen difficulties are encountered in index preparation, in reproducing the material, or in distributing the completed volumes.

During the next reporting period we will continue our efforts of abstracting and editing, will begin final typing on the unclassified volume, and will send out a letter requesting that potential users provide information for us to prepare a suggested distribution list for the bibliography.

Respectfully submitted,

H. A. Corriher, Jr.
Project Director, A-755

GEORGIA INSTITUTE OF TECHNOLOGY
ENGINEERING EXPERIMENT STATION
ATLANTA, GEORGIA 30332

17 June 1966

NOTICE

This document is not to be used by anyone.

Prior to 1-18 1970
without permission of the Research Sponsor and the Experiment Station Security Office.

U. S. Army Electronics Command
Attention: Dr. Leonard Hatkin
AMSEL-HL-R
Fort Monmouth, New Jersey 07703

Reference: Contract No. DA 36-039 AMC-03759(E)
Order No. 33040-PM-64-91

Title: Bibliography of Radar Reflection Characteristics

Subject: Monthly Letter Type Report No. 28
15 May 1966 through 14 June 1966

Gentlemen:

In response to our announcement to over 250 activities concerning the forthcoming availability of the bibliography, we have received requests from about 50 agencies for initial distribution. Most of the requests have been for single sets of the material, although several of the larger organizations desire several sets; this was anticipated. A date of 30 June was established for reply to our letter, and we will write follow-up letters to those not heard from by this date. After the requests are in, it is possible that a meeting of ECOM, ARPA, and Georgia Tech personnel should be held in order to decide on an equitable distribution of the available sets.

Modification No. 5 to the referenced contract has been received and provides an additional three months for performance without additional funds. We are hopeful that this delayed delivery date can be met. We are making good progress on final preparation of material for the unclassified volume, and most of the abstracts have been completed for the classified volumes.

During the next reporting period we will continue our routine efforts of abstracting and editing, and will work on assembling the unclassified abstracts and references for preparation of Volume VII of the bibliography.

Respectfully submitted,

H. A. Corriher, Jr.
Project Director, A-755

A-755

GEORGIA INSTITUTE OF TECHNOLOGY
ENGINEERING EXPERIMENT STATION
ATLANTA, GEORGIA 30332

15 July 1966

NOTICE
This document is not to be used by anyone.
Prior to 1-18 1970
without permission of the Research Sponsor and the Experiment Station Security Office.

U. S. Army Electronics Command
Attention: Dr. Leonard Hatkin
AMSEL-HL-R
Fort Monmouth, New Jersey 07703

Reference: Contract No. DA 36-039 AMC-03759(E)
Order No. 33040-PM-64-91

Title: Bibliography of Radar Reflection Characteristics

Subject: Monthly Letter Type Report No. 29
15 June 1966 through 14 July 1966

Gentlemen:

We are continuing to receive replies to our announcement of the forthcoming availability of the bibliography and therefore have delayed a follow-up letter to those agencies not heard from by 30 June. Replies have not yet been received from the Army Electronics Command and the Advanced Research Projects Agency concerning their own needs and suggestions for additional addresses for announcements.

Open literature references for the unclassified volume have been typed and are now being proofread. This section of the material will be 102 pages long and include 1707 items. Report items are being placed in final order and this will be completed soon and typing begun. We still have a number of classified abstracts to prepare.

DCASR-Atlanta has just notified us that the security clearance of the outside supplier selected for binding the final volumes is being administratively terminated. Since so few sources of this service are available, this is a serious problem which is being investigated.

During the next reporting period we will continue our routine efforts of abstracting, editing, and proofreading. Preparation of the unclassified volume (Volume VII) of the bibliography will also continue.

Respectfully submitted,

H. A. Corriher, Jr.
Project Director, A-755

A-955

GEORGIA INSTITUTE OF TECHNOLOGY

ENGINEERING EXPERIMENT STATION

ATLANTA, GEORGIA 30332

19 August 1966

U. S. Army Electronics Command
Attention: Dr. Leonard Hatkin
AMSEL-HL-R
Fort Monmouth, New Jersey 07703

Reference: Contract No. DA 36-039 AMC-03759(E)
Order No. 33040-PM-64-91

Title: Bibliography of Radar Reflection Characteristics

Subject: Monthly Letter Type Report No. 30
15 July 1966 through 14 August 1966

Gentlemen:

We have received 108 replies to our announcement of the forthcoming availability of the bibliography and have been requested to supply a total of 159 sets or partial sets of the material. Follow-up letters have been sent to 154 activities which have not been heard from yet. Also, we have not received replies from the Army Electronics Command and the Advanced Research Projects Agency. Our letter to these two activities requested statements of their own needs and suggestions for additional addresses for announcements.

Abstracts for the unclassified volume are still being processed and most of the work has been completed. We expect to be typing this portion of Volume VII soon. There are still a number of classified documents which have not been abstracted and this material will be processed immediately after the unclassified material is finished. The indexes which will go in Volume VII will be prepared later when all abstracts have been processed and final identification numbers assigned.

We have investigated the problem of finding a cleared facility to bind the volumes, but this problem has not been satisfactorily resolved. If the original supplier does not have a security clearance at the time the need for his services arises, we may be forced to consider alternative forms of binding which can be accomplished at Georgia Tech or some other properly cleared activity. Investigation of this serious problem is continuing.

We continue to remain behind schedule on this program. Unfortunately, most of the work requires orderly, sequential processing of material and additional personnel would do little to speed up this processing. We will ask for an extension of delivery time on the referenced contract and will examine the situation to see if additional funds will also be required.

During the next reporting period we will continue our routine efforts of abstracting, editing, and assembly of material into the various bibliography volumes.

Respectfully submitted,

H. A. Corriher, Jr.
Project Director, A-755

A-755

GEORGIA INSTITUTE OF TECHNOLOGY

ENGINEERING EXPERIMENT STATION

ATLANTA, GEORGIA 30332

19 September 1966

NOTICE

This document is not to be used by anyone.

Prior to ~~9-19~~ 1-18 19~~68~~ 70

without permission of the Research Sponsor and the Experiment Station Security Office.

U. S. Army Electronics Command
Attention: Dr. Leonard Hatkin
AMSEL-HL-R
Fort Monmouth, New Jersey 07703

Reference: Contract No. DA 36-039 AMC-03759(E)
Order No. 33040-PM-64-91

Title: Bibliography of Radar Reflection Characteristics

Subject: Monthly Letter Type Report No. 31
15 August 1966 through 14 September 1966

Gentlemen:

Our follow-up letter to 154 activities regarding the availability of the bibliography has produced an additional 28 responses. At this time, we have heard from only slightly more than half of the activities to whom letters have been sent. This low response can partly be attributed to the fact that the letters were addressed to activities rather than to individuals. It seems doubtful that further follow-up will be worthwhile, and it seems best to provide additional copies to the Defense Documentation Center and then make an appropriate announcement to individuals.

We remain behind schedule on our work but have made substantial progress during this reporting period. A request has been submitted to change the delivery date for the bibliography to 15 December 1966. Current funds are not adequate to complete the work, but additional funds have not yet been requested.

Binding of the classified portion of the bibliography remains a problem. The only local commercial source has declined to estimate the job for delivery before January 1967 because of his current heavy backlog. A further difficulty is that we desire to use "Wire-O" binding for the thick volumes. This binding allows the pages to lie flat and is much more durable than ordinary metal or plastic spiral binding. However, the only local supplier is the original source whose clearance is currently in doubt. We are continuing to investigate the matter.

During the next reporting period we will continue our routine efforts of abstracting, editing, and assembly of material into the various bibliography volumes. The binding problem will be further examined.

Respectfully submitted,

H. A. Corriher, Jr.
Project Director, A-755

REVIEW

PATENT 2-10 19.62 BY....

FORMAT 2-10 19 62 BY

A-755

GEORGIA INSTITUTE OF TECHNOLOGY
ENGINEERING EXPERIMENT STATION
ATLANTA, GEORGIA 30332

19 October 1966

U. S. Army Electronics Command
Attention: Dr. Leonard Hatkin
AMSEL-HL-R
Fort Monmouth, New Jersey 07703

Reference: Contract No. DA 36-039 AMC-03759(E)
Order No. 33040-PM-64-91

Title: Bibliography of Radar Reflection Characteristics

Subject: Monthly Letter Type Report No. 32
15 September 1966 through 14 October 1966

Gentlemen:

We have begun final typing of the abstracts and references to unclassified reports. These total 1321 numbered items and will be added to the 1707 journal items, plus the indexes, to form the unclassified volume (Volume VII). Abstracting is virtually complete, and we will process material into the confidential volume within the next week or so.

While binding remains a problem, the uncertain work loads and security clearances of suppliers prevent our making a determination of the best course to follow until the material is virtually ready to bind. We will continue to keep in touch with the situation, and will notify the Sponsor if a substantial departure from the previously used binding style is anticipated.

Although we remain behind schedule on our work, we have made substantial progress during this reporting period. No reply has been received to our request to change the delivery date for the bibliography to 15 December 1966. Current funds are not adequate to complete the work, and additional funds are being requested.

During the next reporting period we will continue our routine efforts of editing final typing, and assembly of material into the various bibliography volumes.

Respectfully submitted,

H. A. Corriher, Jr.
Project Director, A-755

REVIEW

PATENT 2-10 19 67 BY

FORMAT 2-10 19 67 BY

/ 755

GEORGIA INSTITUTE OF TECHNOLOGY

ENGINEERING EXPERIMENT STATION
ATLANTA, GEORGIA 30332

15 November 1966

NOTICE

This document is not to be used by anyone.

Prior to ~~11-15~~ 1-18 19~~68~~ 70
without permission of the Research Sponsor
and the Experiment Station Security Office.

U. S. Army Electronics Command
Attention: Dr. Leonard Hatkin
AMSEL-HL-R
Fort Monmouth, New Jersey 07703

Reference: Contract No. DA 36-039 AMC-03759(E)
Order No. 33040-PM-64-91

Title: Bibliography of Radar Reflection Characteristics

Subject: Monthly Letter Type Report No. 33
15 October 1966 through 14 November 1966

Gentlemen:

We have completed abstracting, and are assembling the classified material to form the individual volumes. Typing continues on the unclassified volume, and the classified volumes will be typed upon completion of this work. Typing is a considerable task since the bibliography will total about 1300 high-density pages. We are ready to begin preparation of the subject index which will require posting about 23,000 terms from the abstracts to index cards.

As discussed in previous letter reports, the amount of material processed for the bibliography has considerably exceeded estimates and we have accordingly had to ask for extensions of time. On 26 October 1966 we submitted a request to increase the contract funds by $13,700 and provide a new delivery date of 15 January 1967 for the bibliography. This constitutes an increase of 9.9% in funds to cover an increase in items processed of 32% over the figures applicable for Modification No. 3 to the subject contract. We hope that this request will be acted upon favorably.

During the next reporting period we will continue our efforts of assembling material into the classified volumes, final editing, typing, and preparation of the subject index.

Respectfully submitted,

H. A. Corriher, Jr.
Project Director, A-755

REVIEW

PATENT 2-10 1967 BY

FORMAT 2-10 1967 BY

A-755

GEORGIA INSTITUTE OF TECHNOLOGY
ENGINEERING EXPERIMENT STATION
ATLANTA, GEORGIA 30332

16 December 1966

NOTICE
This document is not to be used by anyone.
Prior to ~~12-16~~ 1-18 19~~68~~ 70
without permission of the Research Sponsor
and the Experiment Station Security Office

U. S. Army Electronics Command
Attention: Dr. Leonard Hatkin
AMSEL-HL-R
Fort Monmouth, New Jersey 07703

Reference: Contract No. DA 36-039 AMC-03759(E)
Order No. 33040-PM-64-91

Title: Bibliography of Radar Reflection Characteristics

Subject: Monthly Letter Type Report No. 34
15 November 1966 through 14 December 1966

Gentlemen:

We have now completed typing the unclassified report abstracts; the references to journal articles were typed some time ago. Except for the indexes and introduction, typing of material for the unclassified volume has been completed. We are nearing completion of the task of posting to index cards the subject and author items for the unclassified reports and journals, but typing of these indexes will not begin until classified material has been handled also.

Thus far we have not received word on any action on our requests for additional time and additional funds. We are hopeful that these requests will be acted upon favorably and are meanwhile proceeding to complete the work as soon as possible.

During the next reporting period we will continue our efforts of final editing and assembling the classified volumes, preparing the indexes, typing and proofreading.

Respectfully submitted,

H. A. Corriher, Jr.
Project Director, A-755

HAC:jan

REVIEW
PATENT 2-10 1967 BY
FORMAT 2-10 1967 BY

A-755

GEORGIA INSTITUTE OF TECHNOLOGY

ENGINEERING EXPERIMENT STATION

ATLANTA, GEORGIA 30332

16 January 1967

U. S. Army Electronics Command
Attention: Dr. Leonard Hatkin
AMSEL-HL-R
Fort Monmouth, New Jersey 07703

Reference: Contract No. DA 36-039 AMC-03759(E)
Order No. 33040-PM-64-91

Title: Bibliography of Radar Reflection Characteristics

Subject: Monthly Letter Type Report No. 35
15 December 1966 through 14 January 1967

Gentlemen:

No official reply has been received to our request for additional time and additional funds to complete the bibliography under the reference contract. However, we are proceeding on the basis that both will be provided and we are therefore continuing the work and the monthly reports.

In the absence of an official revised delivery date, we submitted on 13 January 1967 two Xerox copies of a substantial block of material for review. This material consists of the unclassified report abstracts and journal references to be used in Volume VII of the bibliography. Except for completion of final proofreading and correction of typographical and other minor errors, this material is in final form for reproduction when approved.

The project staff is extremely small now, and progress during this monthly reporting period was slowed by end-of-year vacations. However, we have finished posting the unclassified items to the author and subject indexes, and only a very small amount of checking remains. Also, most of the unclassified abstracts have been proofread and corrected, as stated above.

During the next reporting period we will finish our work on the unclassified abstracts and references, and we expect to make substantial progress on typing and indexing the classified material.

Respectfully submitted,

H. A. Corriher, Jr.
Project Director, A-755

HAC:lb

A-755

GEORGIA INSTITUTE OF TECHNOLOGY

ENGINEERING EXPERIMENT STATION

ATLANTA, GEORGIA 30332

15 February 1967

~~NOTICE~~

~~This document is not to be used by anyone~~

~~Prior to 2-14 1967~~

without permission of the Research Sponsor

and ~~the Experiment Station Security Office~~.

Activity Supply Officer, USAELRDL
Building 2504, Charles Wood Area
Fort Monmouth, New Jersey 07703

For: Radar Technical Area, CS/TA Laboratory
Inspect at Destination
Order No. 33040-PM-64-91

NOTICE

This document is not to be used by anyone.

~~2-15~~ 1-18 19~~67~~70

Reference: Contract No. DA 36-039 AMC-03759(E)

Title: Bibliography of Radar Reflection Characteristics

Subject: Monthly Letter Type Report No. 36
15 January 1967 through 14 February 1967

Gentlemen:

Although no official reply has been received to our request for additional time and additional funds to complete the bibliography, we are proceeding on the basis that both will be provided in accordance with negotiations now underway.

Index posting has been finished for the Unclassified abstracts and references; except for corrections, this material is now ready for incorporation into the Unclassified volume. We have made substantial progress on the Confidential volume during this report period. The majority of the material has been typed in final form and index posting is proceeding well. The average number of abstracts per page is somewhat higher in the Confidential volume than it was in the Unclassified volume because of a larger number of report series which are treated by a single abstract rather than by a separate abstract for each document.

During the next reporting period we expect to finish the Confidential volume and begin final preparation on the Secret volume.

Respectfully submitted,

H. A. Corriher, Jr.
Project Director, A-755

HACjr:lb

REVIEW

2-16 1967 BY

FORMAT 19 BY

A-755

GEORGIA INSTITUTE OF TECHNOLOGY

ENGINEERING EXPERIMENT STATION

ATLANTA, GEORGIA 30332

17 March 1967

NOTICE

This document is not to be used by anyone.

Prior to ~~3-1-~~ 1-18 19~~68~~ 70

without permission of the Research Sponsor and the Experiment Station Security Office.

Activity Supply Officer, USAELRDL
Building 2504, Charles Wood Area
Fort Monmouth, New Jersey 07703

For: Radar Technical Area, CS/TA Laboratory
Inspect at Destination
Order No. 33040-PM-64-91

Reference: Contract No. DA 36-039 AMC-03759(E)

Title: Bibliography of Radar Reflection Characteristics

Subject: Monthly Letter Type Report No. 37
15 February 1967 through 14 March 1967

Gentlemen:

Modification No. 6 to the reference contract has been received; the modification extends the period of performance to 14 April 1967 and increases funds by $13,700. This is the last Letter Report required by the modified contract, and will be used to summarize the situation.

Approval has been received from the Electronics Command for the draft of the abstracts and references for Volume VII (Unclassified, 466 pp) of the bibliography. Abstracts and references for Volume VIII (Confidential, 266 pp) have now been typed and are ready for proofreading and correction. Index posting for these two volumes has been completed. Typing on Volume IX (Secret), and final editing on Volume X (Secret-Restricted Data) are now underway. We expect to submit draft copies of the remainder of the bibliography by the contract completion date of 14 April 1967, although there is a possibility that the introduction and indexes will be delayed slightly past this date.

An approved distribution list has been received from ECOM for the CS, NV, and TA Laboratories and several other agencies. (The Advanced Research Projects Agency has not supplied a distribution list.) We will combine this information with the requests resulting from our direct inquiry of possible recipients, and will submit a tentative distribution list for approval by ECOM and ARPA.

The report file generated under this contract represents an appreciable investment in reproduction, procurement, and bibliographic and security control costs. This material has continuing utility for providing information on reflectivity to the radar technical community and in maintaining continuity

REVIEW

PATENT 4-10 1967 BY...

FORMAT .... 19........ BY

for a follow-on bibliography program for which Navy support is expected shortly. Therefore, we intend to request permission to maintain this collection intact and are hopeful that this can be approved.

We believe that the bibliography will be a useful tool, and appreciate the support of the Electronics Command on this program.

Respectfully submitted,

H. A. Corriher, Jr.
Project Director, A-755

HACjr:lb

Copy No. ______ of 500 copies

TECHNICAL REPORT ECOM-03759-F, Part 1 of 4 14 April 1967

GEORGIA INSTITUTE OF TECHNOLOGY
Engineering Experiment Station
Atlanta, Georgia 30332

A BIBLIOGRAPHY OF RADAR REFLECTION CHARACTERISTICS

Volume VII

Compiled by

H. A. Corriher, Jr. and Berry O. Pyron

with

H. H. Jenkins
J. L. Eaves
R. P. Zimmer
and others

Prepared for

U.S. Army Electronics Command
Fort Monmouth, New Jersey

and

Advanced Research Projects Agency
Department of Defense

Contract No. DA 36-039 AMC-03759(E)
DA Project No. 1Z6-20901-A-188-02
ARPA Order No. 672

(This page intentionally left blank.)

PREFACE

This is the seventh in a series of volumes prepared by Georgia Tech as a comprehensive guide to the literature on radar reflection characteristics. Volumes I through III, compiled under Navy Contract NOrd-11386, surveyed material available through 1951. Volumes IV through VI, prepared under Army Contract DA 36-039 SC-73133, extended the coverage through 1956. The present Volumes VII through X have been prepared under Army Electronics Command Contract DA 36-039 AMC-03759(E) to cover the eight-year period 1957-1964.

Previous volumes of the bibliography, together with a "textbook" summarizing much of the technical information of the first three volumes, are available from the Defense Documentation Center (DDC) as follows:

Vol. I (U), Index	AD 13 211	Suppl. to "Textbook" (S)	AD 54 294
Vol. II (C), Abstracts	AD 3 414	Vol. IV (U), Index	AD 210 185
Vol. III, (S), Abstracts	AD 8 866	Vol. V (C), Abstracts	AD 304 851
"Textbook" (C)	AD 60 221	Vol. VI (S), Abstracts	AD 304 852

Volume VII of the current set contains a Guide to Use of the Bibliography; Source, Author, and Subject Indices to Volumes VII through X; abstracts of Unclassified reports; and references to journal articles. Confidential material is treated in Volume VIII, Secret material in Volume IX, and material classified Secret-Restricted Data (or having certain distribution limitations) in Volume X.

The interest, cooperation, and assistance of a large number of persons were essential to the compilation of this bibliography. Appreciation for their cooperation and interest is given to Dr. Leonard Hatkin and Mr. Charles R. Eason of the U.S. Army Electronics Command, under whose sponsorship the program was conducted. The help of Mr. Morris I. Witow in arranging for additional support from the Advanced Research Projects Agency is also specifically acknowledged.

We greatly appreciate the willing assistance of DDC personnel in rendering the specialized services needed by a program of this nature, as well as in rapidly filling large orders for documents. Through the cooperation of the Battelle-Defender Information Analysis Center at Battelle Memorial Institute, Recon Central at the Air Force Avionics Laboratory, and the Office of Scientific and Technical Information of the National Aeronautics and Space Administration, many references are included which might otherwise not have been identified.

In addition to the individuals listed on the title page, many others at Georgia Tech contributed to this work. For example, abstracting services were also provided by A. P. Sheppard, C. R. Driskell, R. D. Trammell, and R. G. Shackelford. Open literature searches were performed by Jeremiah Rose and Mrs. Elizabeth Bone. Mrs. Stanlee Davis and Mrs. Dorothy Harrison assisted with abstracting, editing, and indexing. Mrs. Lola Paille of the Georgia Tech Price Gilbert Library was responsible for document orders to DDC and assisted in identification of various reports. The accuracy and faithfulness of Mrs. Linda Black in secretarial duties from the initial work on references and record-keeping through the final typing is acknowledged and deeply appreciated.

(This page intentionally left blank.)

INTRODUCTION

Volumes VII through X of this bibliography are intended to serve as a comprehensive guide to the classified and unclassified literature issued on the subject of radar reflection characteristics during the period 1957-1964. The present volumes contain abstracts or title listings for approximately 4000 reports and symposium papers, and references to over 1700 journal articles and other items from the open literature.

Much of the pertinent material on this subject is in the form of reports of studies sponsored by U.S. or foreign governments. Since such reports are less readily accessible than are scientific journals, the intent has been to abstract them in sufficient detail that the reader having limited interest in a subject may not need to obtain the documents themselves. Normally, the description should also enable a user with more detailed interests to determine whether or not a full copy of a particular report should be obtained. Because of the extremely large number of documents covered by the present four volumes, the abstracts are frequently somewhat shorter than in earlier volumes of the bibliography; however, they have been prepared with the same objectives as previously.

Pertinent papers appearing in various scientific and technical journals have not been abstracted since the journals themselves are widely available. Titles, authors, and bibliographic data only are given for journal articles, usually together with references to one or more abstracts in standard abstract sources.

Scope

Emphasis in this bibliography is on the reflection properties of radar targets. Specifically excluded are all aspects of operational radar equipment, except (to some limited degree) insofar as they are influenced by or associated with the target's effect on the returned radiation. Equipment and techniques used in experimental measurement of target reflection properties and related phenomena are included, however. While the topics of direct and scatter propagation, refractive effects, etc., are related to radar reflection, they were considered to have only limited pertinence for earlier volumes of the bibliography and were ordinarily excluded therefrom. These topics are covered more thoroughly in the present volumes because of their increasing importance in radar systems.

The scope encompasses all kinds of targets, artificial and natural, including reflection from idealized geometrical shapes, such man-made objects as aircraft, missiles, ground vehicles, and confusion reflectors (chaff and rope), and natural reflectors such as ground, sea, meteorological phenomena, ionosphere, and meteor trails. Extensive treatment is also given to the closely related fields of radar camouflage and absorbing coatings, and of radar cross-section prediction.

Considerable material is included on those aspects of basic electromagnetic theory concerning scattering and diffraction, but coverage of these broad topics is not exhaustive. Optical scattering, diffraction, and reflection have been ignored except for a few documents on fundamental theory which appear applicable to reflection at radar wavelengths. Laser reflection studies and radar reflection measurements obtained by optical analog techniques are included.

Antenna and radome studies, per se, have been excluded, but the antenna as a target object was considered pertinent. While papers on radar reflections from meteors and extraterrestrial bodies are abstracted, material relating to passive aspects of radio astronomy has been excluded.

Extent of Literature Search

The primary source of information on references for this bibliography has been the Defense Documentation Center (DDC). Several broad custom abstract searches were requested from DDC and resulted in over 6000 references for review. For about half of these references, the documents were either ordered or examined at DDC to determine their pertinence. Individual issues of the DDC Technical Abstract Bulletin were also searched for the years 1964 and 1965. Additional references for ordering documents (or existing abstracts themselves) were obtained from Battelle-Defender Information Analysis Center at Battelle Memorial Institute, and from Recon Central at the Air Force Avionics Laboratory. The Office of Scientific and Technical Information of the National Aeronautics and Space Administration provided results of a search of their holdings. Available bibliographies of several individual agencies were screened and yielded additional references not available otherwise.

Although surveys for previous volumes of this bibliography included checking of the reference lists of all documents, this was not accomplished during the present program. Also, it was not possible to canvass the many agencies known to be active in radar reflection work.

A careful search for pertinent journal articles was made using the abstracts and references section of Electronic Technology, both Series A and B of Science Abstracts, Meteorological and Geoastrophysical Abstracts, Technical Translations, and International Aerospace Abstracts. The indices or tables of contents were searched for those journals represented by twenty or more references from the initial search. The open literature section of the bibliography includes conference records, monographs, and books, as well as journal articles.

Although very extensive, the present bibliography cannot be considered exhaustive for the time period 1957-1964. Any user of the bibliography who knows of worthwhile material that has been overlooked is requested to provide information thereon to:

Engineering Experiment Station
ATTN: Project A-755 (Mr. H. A. Corriher, Jr.)
Georgia Institute of Technology
Atlanta, Georgia 30332

Obtaining Listed Documents

Most of the documents abstracted in the bibliography can be obtained from DDC by qualified requestors. For routine orders, only the AD number (shown in the abstract heading, if known) is necessary for identification. When the AD number is not available, the heading usually gives sufficient information for ordering by description. Documents having distribution limitations (the "L" documents) can also be obtained from DDC if the specified procedures are followed.

Proprietary and Foreign Information

Several of the documents abstracted in this bibliography have been marked as containing proprietary information. Most of the documents themselves have no particular limitations on distribution and are available from DDC. In some cases we have identified such documents by the expression, "Contains proprietary information; available from DDC," but this cautionary note may not always be shown. Normally proprietary material in these and similar documents is not further identified, and it is possible that some of the abstracts themselves contain information considered to be proprietary by the originator. The user is therefore cautioned against improper use of this information, and in case of doubt should examine the complete document to establish any limitations on its use.

Part of the information contained herein has been released to the U.S. Government by foreign governments (the United Kingdom and Canada, for example) for defense purposes only. Such information must be accorded the same degree of security protection as that accorded by the originating government and must be disclosed only within the Defense Department of the U.S. Government and its defense contractors, unless otherwise authorized by the originator. Furthermore, such information may be subject to privately owned rights and may not be dealt with in any manner likely to prejudice the rights of any owner to obtain patent or statutory protection therefor. Before any use is made of the information for purpose of manufacture, the authorization of the appropriate government must be obtained.

Security Notes

Security classifications of reports and report titles have been given in the abstract headings as they were shown on the actual documents or on abstract cards from DDC or other sources. If the classification of the title was not indicated on the document or other source, it is normally marked "NV" for "not verified." In caseswhere the originator did not indicate title classification on the document and DDC has assigned one, the classification is followed by an asterisk, (e.g., U*). When the title classification is marked "NV" or left unmarked, it must be assumed to be the same as that of the document in the absence of positive information to the contrary. In particular, title classifications are not marked on British documents although frequently such titles are considered to be classified.

The applicable downgrading and declassification group is shown as a 1, 2, 3, or 4 following the security classification itself. The Industrial Security Manual or other appropriate security regulations should be consulted for the definitions of these designations. If the group number was not available, the classification is followed by "G?", or by no mark at all.

We cannot, of course, guarantee the permanence of any indicated classification and the user is cautioned that they may have changed since the date of our information. Also, although great care has been exercised in treating the security marking of the titles and abstracts, it is possible that a few errors have occurred in this large a quantity of material. Anyone locating such discrepancies is requested to notify us so that errata can be distributed.

(This page intentionally left blank.)

TABLE OF CONTENTS

(This page intentionally left blank.)

ABERDEEN PROVING GROUND, BALLISTIC RESEARCH LABORATORIES

5001 BRL Memorandum Report 1287 (ARPA Satellite Fence Series, Report 16), "Technical Summary Report 3," L. G. deBey, 1 Jul 60, (111:-), Unclassified, AD 402 078.

A summary of the development of DOPLOC, a dark satellite tracking system, over the period July 1959 to July 1960. Experimental use of the field station facilities for tracking non-radiating satellites is described and sample data are shown to illustrate the system performance. A compilation of the satellites tracked by reflection summarizes pertinent tracking data, including signal duration, signal strength, and effective reflection cross-section. Observed cross-section variations are discussed. Evidence of ion trails of several minutes duration after the passage of 1958 Delta (Sputnik III) is noted. Tracking efforts on radiating satellites are summarized as used in connection with the design and development of DOPLOC system components and data processing.

5002 BRL Memorandum Report 1330 (ARPA Satellite Fence Series, Report 22), "DOPLOC Observations of Reflection Cross Sections of Satellites," H. T. Lootens, Mar 61, (187:6), Unclassified, AD 259 123.

This report presents reflection cross-sections observed for eight satellites between January 1959 and July 1960, using the DOPLOC dark satellite detection system. Several related areas are discussed: satellite signature, spin and tumble, scintillation, and ionized trails. The system uses a 50-kw, 108-Mc, CW transmitter located at Fort Sill, Oklahoma, which feeds one of three narrow-beam, high-gain antennas, one of which is directed 20° above the northern horizon, one 20° above the southern horizon, and one vertically. The signal reflected from a satellite passing through the transmitter beam is received at one or both of two receiving stations. Each receiving station has three high-gain antennas oriented to "see" the space volume illuminated by the transmitter. (See also Abstract 5004 below.)

5003 BRL Memorandum Report 1368, "Feasibility Test of an Upper Atmosphere Gun Probe System," S. T. Marks, L. C. MacAllister, J. W. Gehring, et al., Oct 61, (67:11), Unclassified, AD 267 354.

This document deals with feasibility tests on the concept of using a smoothbore 120-mm gun to convey a fin-stabilized 60-mm probe to the upper atmosphere. Reflectivity considerations are limited to brief comments about the performance of a chaff package to be ejected in studying upper-atmosphere winds.

5004 BRL Report 1195, "The DOPLOC Dark Satellite Tracking System," A. L. G. deBey and V. W. Richard, Mar 63, (21:6), Unclassified, AD 403 879.

Description of the DOPLOC (Doppler phase lock) dark satellite-tracking system, used to track projectiles, rockets, guided missiles, and space vehicles; some results are included. A method discussed enables a complete set of orbital parameters to be determined from the Doppler data recorded from a single pass of a satellite.

Note: Also published in Vol. I of the Proceedings of 1962 Army Science Conference, West Point, New York, 20-22 June 1962.

ABERDEEN PROVING GROUND, DEVELOPMENT AND PROOF SERVICES

5005 Report DPS-424, "A Survey of the Methods of Determining the Radar Cross Section of Aircraft and Missiles," M. W. Hutchins, Jan 62, (15:5), Unclassified, AD 269 529.

ABERDEEN PROVING GROUND, DEVELOPMENT AND PROOF SERVICES (CONT.)

5005 (Cont.)

An elementary survey of the several theoretical and experimental approaches that are available for determining radar cross-sections. Only the briefest description is given of each approach (e.g., physical optics). An appendix proposes the establishment of a modeling facility at Aberdeen.

ACF INDUSTRIES, INC.

5006 External Technical Memorandum E-13, "Theoretical Evaluation of HF-Backscatter Observations," M. L. Phillips, 1 Dec 60, (9:5), Unclassified, AD 403 501.

Analysis of Moore and Williams (Proc. IRE 45, 228-238 (1957)) on radar terrain return at near-vertical incidence is extended to the case of backscatter involving ionospheric reflection and propagation over a curved earth. An expression for received backscattered power is obtained in terms of: effective reflectivities for ionosphere and earth, an "overall convergence factor" as discussed by Bremmer (Terrestrial Radio Waves, H. Bremmer, Elsevier, 1949), and other factors. The problem of obtaining realistic estimates for some of the factors is briefly discussed.

5007 External Technical Memorandum 29, "A Preliminary Look at Backscatter Observations Along a High Latitude Radio Path," W. T. Whelan, Nonr-2455(00), 10 Dec 63, (1 vol.:-), Unclassified, AD 435 109L. (Direct request to ONR, Department of the Navy, Washington 25, D. C., Attn: Code 418.)

(DDC) Statistics are presented for backscatter echoes observed by an HF pulse radar for nearly 24 months. The data were gathered at a monostatic transmitting and receiving site located near Washington D. C., along a transmission path which passed near to the geographic north pole and which can be best described as a transauroral path. The observations were made from February 1959 to March 1961 during which time the average smoothed sunspot number decreased from 150 to less than 70. Conclusions are given regarding effects of the geophysical environment on the observed data and the intercomparison of various other propagation evaluation techniques with that of ground backscatter.

AERO GEO ASTRO CORPORATION

5008 "Technical Note on Reflection and Modulation of Microwaves by Plasmaguide Waves," J. F. Asmus, Nonr-3163(00), ARPA Order 235, 1 Aug 62, Unclassified.

(BD-3613) There has been considerable interest in problems of the cross-modulation and harmonic generation of electromagnetic waves within a plasma. This is relevant to ionospheric phenomena (the Luxembourg effect, for example), wave propagation in the solar corona, and techniques for frequency multiplication in a plasma. The usual wave interaction in an isotropic uniform plasma is a quadratic effect arising from the modulation of the effective collision frequency and leading to combination frequencies $\omega_1 \pm 2\omega_2$ where ω_1 and ω_2 are the frequencies of the two original waves. It has been suggested that electron density fluctuations proportional to the electric field may exist in nonuniform regions, leading to first-order combination frequencies, $\omega_1 \pm \omega_2$. Since slow plasmaguide waves are also associated with perturbations of charge density in nonuniform plasmas, such waves may be useful for studying the above effect.

AERONUTRONIC DIVISION, FORD MOTOR CO.

5009 Technical Report U-1029, "Telemetry Blackout and Reentry Radar Cross Section for Different Reentry Vehicles," E. Bauer and P. A. Clavier, AF 04(647)-280, 20 Oct 60, (-:6), Unclassified.

(BD-2357) Transmission and reflection coefficients are calculated for normal incidence of 250 Mc and 5 Gc rf signals onto the heated shock and boundary layers surrounding a blunt-nosed body and a slender low-drag cone at peak re-entry heating. The calculation accounts for the fact that the air-plasma boundary around the re-entry body is continuous rather than abrupt at stations well towards the rear of the body. For the slender cone, the signal attenuation is small (less than 5 dB at both frequencies); at 250 Mc the reflection and transmission coefficients are both about 0.3, while at 5 Gc the transmission coefficient is very large (0.7) and the reflection coefficient is about 2%. For a typical model of a blunt-nosed ICBM nosecone, transmission and reflection of microwave energy are both negligible, and virtually all incident rf energy is absorbed in the plasma sheath.

AEROSPACE CORPORATION

5010 Report TDR-930(2119)TN-1, "Measurement of Reduced Radar Cross Sections," R. C. Hansen, H. E. King, and C. G. Bachman, AF 04(647)-930, Oct 61, (60:36), Unclassified, AD 266 739.

This report has been superseded and replaced by a later version, see next abstract.

5011 Report TDR-930(2119)TN-1 (Reissue A) (BSD-TDR-62-300), "Techniques for Measurement of Reduced Radar Cross Sections," C. G. Bachman, H. E. King, and R. C. Hansen, AF 04(695)-69, Oct 62, (66:54), Unclassified, AD 292 955.

This report describes an investigation into the problems of measuring low RCS's of physically large objects, three of which are (1) minimum distance between antenna and target, (2) unwanted background scattering, and (3) target support of negligible cross-section. Five types of measurement ranges are evaluated quantitatively in terms of these problems. Typical equipment block diagrams for each type are included. The types are as follows:

Anechoic Chambers. The anechoic chamber is simply a room lined with absorbing material. Various room arrangements are used such that undesired background scattering arrives at the receiver antenna via multiple-bounce paths.

Radome- or Balloon-Covered Ranges. The radome seems to be unsatisfactory for small cross-section targets.

Conventional Outdoor Ranges. Most full-scale ranges are of this type, which, however, has three inherent drawbacks: (1) lack of control over physical environment; (2) admission of significant specular contribution to background; and (3) admission of a variety of non-specular reflection paths.

Ground-Plane Ranges. In the ground-plane range, the ground is made flat and smooth with respect to λ, and the target is located at a maximum in the interference pattern of direct and ground-reflected rays.

Oblique Ranges. Ground return is minimized by arranging that the antenna illuminates the target at an oblique angle upward, and by choosing antenna beamwidth so that the ground is illuminated only by low-level side lobes. An undesirably large range height is required.

AEROSPACE CORPORATION (CONT.)

5011 (Cont.)

It was concluded that the ground-plane range and oblique range offer the most promise for obtaining long-distance cross-section sensitivities on the order $10^{-2}\ \lambda^2$ to $10^{-4}\ \lambda^2$.

Note: This report supersedes and replaces an earlier version, previous abstract.

5012 Report TDR-269(9990)-4 (SSD-TDR-64-26), "The Influence of Random Phase Errors on the Edge Response of Synthetic-Aperture Mapping Radar Systems," J. A. Develet, Jr., AF 04(695)-269, 4 Mar 64, (16:4), Unclassified, AD 432 843.

Derivation of the edge response of a synthetic-aperture radar mapping system perturbed by small random phase errors, using as a starting point the ensemble average point-target power response previously derived by the author ("The Influence of Random Phase Errors on the Angular Resolution of Synthetic-Aperture Radar Systems," IEEE Trans. Aerospace Navig. Electronics ANE-11, 1 (Mar 64)). The target field considered is homogeneous rough terrain displaying an abrupt change in reflectivity. Graphs are given for use in estimating "fill in" of roads, rivers, etc., due to small phase errors.

5013 Report TDR-269(9990)-6 (SSD-TDR-64-94), "Image Design for Terrain-Mapping Radar Systems," J. A. Develet, Jr., AF 04(695)-269, 15 May 64, (13:7), Unclassified, AD 600 084.

The theory of parameter estimation is used both to determine a method of post-detection processing for estimating the mean value of ground reflectivity, and to establish quantitative relationships for the number of independent samples which must be processed for a good estimate. Quantitative interrelations are determined for the number of grey levels, dynamic range, and final image sample distance. Formulas, a table, and curves are presented for an ideal terrain-mapper.

5014 Report TDR-269(4250-43)-3 (SSD-TDR-64-108), "Radar Mapping of Distributed Targets," A. W. Rihaczek, AF 04(695)-269, 1 Jul 64, (23:6), Unclassified, AD 604 752.

The problem of obtaining a map of cross-section distribution in target space is examined A continuously distributed target is represented or mapped by a countable number of point targets and analyzed by applying conventional point-target theory. The ambiguity function and conventional statistical analysis are employed to determine the statistical average of the matched-filter output. The sampling theorem is invoked to describe the cross-section distribution, and the total cross-section of a resolution cell is concentrated into a single point target. The common definition of resolution as half-power widths of receiver response in range and range-rate is consequently modified. Two new indices are added: the relative size of the resolution cell compared to the minimum size given by receiver response in range and range-rate, and the equivalent self-clutter cross-section introduced through pulse compression. The resolution cell is essentially determined by the transmitted waveform, and clutter depends upon properties of the target environment. The definition of which targets are "clutter" is left to the user of the map.

Note: This is an extension of work reported by A. Krinitz (see Abstract 5463).

AEROSPACE CORPORATION (CONT.)

5015 Report CSR-469(9990)QBR-1 (Quarterly Bibliography 1, 1 Jul-30 Sep 64), "Quarterly Bibliography of Reports Prepared under Contract AF 04(695)-469," Compiled by S. T. Keasbey, AF 04(695)-469, 30 Nov 64, (30:207), Unclassified, AD 453 209.

About 200 reports pertaining to satellite, launch-vehicle, and ballistic-missile projects are listed. Over half of these appear in the section called "Professional Papers"; unclassified title, publication or symposium, author, clearance date, and classification are included.

5016 Report TDR-469(S5855-30)-1 (BSD-TR-64-152), "Wake Radar Cross Section of Slender Re-Entry Vehicles," F. L. Fernandez, J. L. Carson, and D. A. Anderson, AF 04(695)-469, Oct 64, (51:-), Unclassified, AD 450 601L. (Release only to Department of Defense agencies is authorized. Other certified requesters shall obtain release approval from Ballistic Systems Division, Norton AFB, California, Attn: BSYDF.)

(DDC) This report was not obtained. Descriptors: (*Reentry vehicles, Radar echo areas), Slender bodies, Wake, Laminar boundary layer, Electron density, Mathematical prediction, Fluid flow, Conical bodies.

5017 Report TDR-469(5220-10)-3 (SSD-TDR-64-267), "Transmission and Reflection of Electromagnetic Waves by a Hot Plasma," E. C. Taylor, AF 04(695)-469, 30 Nov 64, (23:7), Unclassified, AD 456 354.

The relativistic form of the Vlasov equation is used to determine transmission and reflection coefficients for electromagnetic waves normally incident on either a plasma half-space or a plasma slab, using the assumption that electrons are specularly reflected at the boundaries. These coefficients are functions of the ratio of the electron thermal speed to the vacuum speed of light, indicating that temperature dependence in these cases is a relativistic effect. Nevertheless, it is seen that the nonrelativistic limits of these coefficients differ from those obtained by using the cold-plasma equations, since the transition to the zero-temperature limit has a nonuniform character.

5018 "Transactions of the Eighth Symposium on Ballistic Missile and Space Technology. Held at the United States Naval Training Center, San Diego, California, on October 16-18, 1963. Volume II, Re-Entry Aerophysics, Penetration, Guidance and Control, Recovery Systems, Space Electromagnetics," Oct 63, Unclassified.

(BD-6356) Contains eight papers, including:

"Electromagnetic Radiation Hazards to Electro-Explosive Devices," R. B. Moody, (USAF Directorate of Aerospace Safety, Norton AFB, California).

This paper makes an elementary evaluation of three general proposals recently made as means or techniques to diminish electromagnetic radiation hazards to electroexplosive devices. The evaluation is predicated on basic antenna theory and the improbability of accidental detonation of electroexplosive devices by radio-frequency radiation. The paper recommends the safety practices of safe-separation distances, hazard assessment through the use of inert devices, and electromagnetic shielding techniques.

AIR FORCE AVIONICS LABORATORY, AIR FORCE SYSTEMS COMMAND

5019 "Radar Reflection Bibliography," 9 Mar 50, (27:138), Unclassified, AD 155 279.

An early bibliography on radar reflectivity containing some 138 items, most with short abstracts, and covering the unclassified and classified literature.

5020 WADD Technical Note 60-100, "Directive Non-Oriented Reflectors As Passive Satellites in Long Distance Communications," Y. E. Stahler and A. L. Johnson, Mar 60, (18:-), Unclassified, AD 235 635.

The use of reflecting bodies as passive satellite relay stations was examined for purposes of global communications. It was determined that orbiting reflectors with high directivity but independent of position and attitude represent the most desirable type. Improved directivity of spherical reflectors may be achieved by applying corner reflectors, conical elements, or dipole arrangements. Optical reflection and backscattering tests for all three types indicated that reflectors consisting of reflecting elements of the first order (geometrical reflecting surfaces or dipole arrays) could improve directivity by up to 13 dB; however, reflecting elements of the second order (lenses combined with reflecting surfaces) revealed an extremely high directivity and versatility in reflection patterns.

5021 WADD Technical Report 60-100, "Effects of Rain Back Scattering on High Frequency Doppler Radars," D. A. Guidice, May 60, (27:10), Unclassified, AD 243 244.

Points out that the narrow beamwidth characteristic of a Doppler radar at higher frequencies increases the system's accuracy and reduces the over-water bias error. The effect of rain backscattering on measurements of aircraft ground speed by Doppler radar is analyzed, and a brief theoretical discussion of backscattering is presented. Backscattered power was measured as a function of rain intensity; the two experimental CW radars used, which operated at 36 and 24 Gc, are described. Data-taking and calibration procedures are explained, and graphs are presented of the experimental results for each equipment, showing the proportional part of transmitted power backscattered as a function of rainfall rate.

Note: Technical information in this report was published originally in a master's thesis prepared by the author for Ohio State University.

5022 ASD-TR-61-658, "Measured Effective Cross-Sectional Area of Thin Dipoles," A. L. Johnson, Jan 62, (14:4), Unclassified, AD 274 139.

Cross-section was measured as a function of orientation angle for isolated copper dipoles of 0.0018-inch diameter, approximating the dimensions to be used in Project West Ford. Dipole length was varied from less than $\lambda/2$ to over $5\lambda/2$, thus varying length-to-diameter ratio from 241 to 1730. Measurements were made at 9 Gc with the plane of polarization coinciding with the plane in which the dipoles were rotated. Results show that very thin dipoles act exceptionally close to theoretical predictions. It is concluded that use of multiple-half-wave dipoles instead of the same number of half-wave dipoles will result in no loss in effective cross-sectional area. In a weight-limited situation, the effective area of multiple-half-wave dipoles will vary as the reciprocal of the multiple-half-wave length. For example, a given weight of four-half-wavelength dipoles will have 1/4 the effective area as the same weight of half-wavelength dipoles.

AIR FORCE AVIONICS LABORATORY, AIR FORCE SYSTEMS COMMAND (CONT.)

5023 ASD-TDR-62-800, "A Review of Phase Centers," D. E. Lewis, Oct 62, (16:17), Unclassified, AD 292 969.

The report is concerned with the problem of finding the effective center of phase of radiation from various types of antennas. Brief comment is made on application of the concept to radar backscattering (largely taken from Peters, Abstract 5647), where it is shown that a tracking radar normally points at the phase center of the reradiated field.

5024 ASD-TDR-63-353, "Corner Reflectors as Elements of Passive Communication Satellites," Y. E. Stahler, Jul 63, (31:6), Unclassified, AD 416 689.

Backscattering from corner reflectors was studied experimentally as part of a program to consider their use as passive satellite communication links. The following corner types were included: two-dimensional corner or diplane (folded plate); spherical corner (quarter of a hemisphere); open and dielectric-filled trihedral corners; and concave cone. All were of size 2.5λ, and a frequency of 12.3 Gc was used.

The following conclusions were reached: (1) the right-angle, or near right-angle, corner represents the optimum for all corner reflectors; (2) two-dimensional corners are unsuitable retro-directive elements because they display a scan-angle in one plane only; (3) all three-dimensional corners exhibit side-scattering in undesired directions; (4) the 90° corner with circular edges (quarter of a hemisphere) provides the highest efficiency as a retro-directive element for a passive communication satellite; (5) other corner structures are rather inefficient reflectors--either the scan angle is very narrow (cones) or much incident energy is reflected to the sides (trihedral corners); and (6) the average scan-angle of corner reflectors is rather small, about 50° to 60°, and overall efficiency in a spherical arrangement does not exceed 10 to 12 dB.

AIR FORCE CAMBRIDGE RESEARCH LABORATORIES

5025 GRD-TN-60-631 (1957 Guenter Loeser Memorial Lecture), "Progress and Prospects of Radar Meteorology," D. Atlas, 1957, (33:-), Unclassified, AD 248 008.

This report, comprising the text and figures of a lecture, is a succinct informal summary of the capabilities, limitations, and prospects of radar as a meteorological tool at the time of its issuance.

5026 AFCRC-TR-59-126, "Experimental Study of a Diffraction Reflector," J. H. Provencher, Apr 59, (22:-), Unclassified, AD 212 926.

Note: This report was not obtained.

5027 AFCRC-TR-59-137, "Air Force Cambridge Research Center Radar Cross-Section Measuring Equipment and Range," B. Gorr, Apr 59, (30:0), Unclassified, AD 214 844.

Description of a CW cross-section measurement range capable of operation at 9302.4 and 3100.8 Mc. Since the range is located on a hill overlooking the ocean, reflections from extraneous objects are reduced to a minimum. RCS data is automatically recorded as a function of target aspect for a full 360° in the plane of measurement. The system consists of a transmitter-frequency generating chain, hybrid tee, stub tuners, horn antenna, crystal mixer, local oscillator, receiver, recorder, and a target turntable which is located approximately 90 ft

AIR FORCE CAMBRIDGE RESEARCH LABORATORIES (CONT.)

5027 (Cont.)

from the antenna. With the stub tuner, it is possible to reduce the background to the noise level of the receiver (approximately 90 dB below maximum return). The system is calibrated by using spheres. A block diagram and typical back-scattering patterns are included.

5028 AFCRC-TR-59-210 (Geophysical Research Papers No. 62), "Spurious Echoes on Radar, A Survey," V. G. Plank, May 59, (51:126), Unclassified, AD 215 470.

A comprehensive review and survey of spurious echoes from many sources, including studies of the following targets at the bands indicated: atmospheric and tropospheric layers (L, S, X, and K); insects (X, K, and Q); birds (L, S, and X); lightning (VHF, L, S, and X); sun (S and X); moon (S); and meteors (X, S, and L).

Echoes from invisible atmospheric layers were attributed to atmospheric subsidence inversion, sea-breeze fronts, thin stratified clouds, and regions of refractive-index gradients. Bunched or layer echoes were observed with a 1.25-cm vertical-pointing radar in the vicinity of sharp moisture gradients. These echoes are probably the summation of backscatter from all favorably spaced and oriented microregions of nonuniform refractive-index gradient within the pulse volume. Some angel activity is attributed to insects and birds. It is reported that only one insect of detectable size per hundred thousand cubic feet, or as few as eight birds per square mile, can completely fill a radarscope with return. Other angels were attributed to numerous refractive-index inhomogeneities present in the region of cloud boundaries, or to "dry" squall lines not associated with clouds or precipitation. Ring angels originating as intense point sources and expanding outward at average radial velocities of 52 mph were observed at L-band; these are believed to be due to point-source gravity waves. Similar echoes are attributed to thousands of birds flying out from a common roosting ground.

It is suggested that "radar flying saucers" which suddenly appear, move at velocities of some 600-2000 mph, and then disappear, may be due to shock waves, reflections from the auroras, or secondary scattering of energy from aircraft. Lightning echoes and sferics are discussed in some detail. It is reported that a lightning channel can be a very strong radar-reflector, equivalent to a large aircraft, when electron densities exceed a critical level and the incidence is near normal. Signals from extra-terrestrial sources are also discussed. Radar echoes from the sun and moon, aurora, and meteors are treated in some detail.

Note: A shorter, non-documented version of this article also was published, see Abstract 7293J.

5029 AFCRC-TR-59-244 (Instrumentation for Geophysics and Astrophysics No. 12), "Theoretical Analysis of the PAR-Scope: An Oscilloscope Display for Weather Radars," E. Kessler, III, Jul 59, (36:20), Unclassified, AD 235 310.

The PAR-Scope, whose display is a profile of the average target reflectivity is described in detail and its performance analyzed theoretically. Sample PAR-Scope displays and associated RHI photographs of a 3.2-cm CPS-9 radar are presented. A means of rapid three-dimensional quantitative mapping of average reflectivity is provided when the PAR-Scope is operated with a scanning antenna, permitting simultaneous operation with the RHI and PPI display. It is shown that reflectivity distributions of major interest can easily be represented to an accuracy within 1 dB of that implicit in the radar calibration.

AIR FORCE CAMBRIDGE RESEARCH LABORATORIES (CONT.)

5030 AFCRL-38, "Measured Radar Backscatter Cross Sections of the Project Mercury Capsule," R. B. Mack and B. B. Gorr, Feb 61, (45:5), Unclassified, AD 259 427.

Radar backscatter cross-section of the Project Mercury capsule was measured by standard modeling techniques at simulated radar frequencies of 440, 933.3, 1184, 2800, and 5600 Mc and for climb angles of 0°, 15°, 30°, 45°, 60°, 75°, and 90°. Both horizontal and vertical polarizations were used. The largest cross-sections over the widest angular intervals were obtained at 933.3 and 2800 Mc, being somewhat higher at the lower frequency.

5031 AFCRL-373, "The Backscatter Cross Sections of a Family of Darts," B. B. Gorr and R. B. Mack, Apr 61, (47:2), Unclassified, AD 267 178.

Radar cross-section measurements were made of a family of darts having fin angles of 15°, 30°, and 45°, and fin widths of 0.6, 1.9, 5.75, 6.0, and 19.0 cm. The measurements were made on a monostatic reflection range with a CW balanced-bridge system, at frequencies of 9302.4 and 3100.8 Mc for both horizontal and vertical polarizations. Included are 117 scattering patterns and very brief descriptions of the models and the measurement system and procedures.

5032 AFCRL-62-497 (Geophysical Research Papers No. 75), "Proceedings of the Symposium on the Astronomy and Physics of Meteors," May 62, (314:-), Unclassified, AD 417 200.

The document includes the texts of papers delivered at a symposium held at the Smithsonian Astrophysical Observatory, Cambridge, Massachusetts, from 28 August to 1 September 1961. Sponsors included the Smithsonian Astrophysical Observatory in Cambridge and the AFCRL. Of the 42 papers, six bear directly on radar observations of meteors; these are individually abstracted below. This report has been published as Volume 7 of Smithsonian Contributions to Astrophysics.

5033 Paper in Abstract 5032. "Limitations of Radar Techniques for the Study of Meteors," J. S. Greenhow (Royal Radar Establishment), (13:19), Unclassified.

Basic theories about scattering from meteor trails are reviewed, and some previously accepted fundamental assumptions are shown to be incorrect. It is shown that the initial radius can be an appreciable fraction of a wavelength even at frequencies as low as 20 Mc. The loss of electrons by attachment processes is shown to be serious in the case of long-duration echoes, and the predicted echo durations may be reduced by several orders of magnitude. (This paper is the same as that of Abstract 8355J.)

5034 Paper in Abstract 5032. "The Relation Between Visual Magnitudes of Meteors and the Durations of Radar Echoes," B. A. Lindblad (Lund Observatory, Sweden), (13:15), Unclassified.

The statistical relation between visual magnitudes of meteors and radar echo durations was investigated. For 688 Perseid meteors observed at 9.2 m, a linear relation is deduced between the logarithm of echo duration and absolute magnitude. It is shown that meteors which lie high in the magnitude-duration diagram are associated with persistent visual trains.

AIR FORCE CAMBRIDGE RESEARCH LABORATORIES (CONT.)

5035 Paper in Abstract 5032. "Radio-Echo Measurements of Meteor Mass Distributions," A. A. Weiss (Commonwealth Scientific and Industrial Research Organization, Australia), (3:5), Unclassified.

Mass distributions were derived for sporadic and shower meteors from radio-echo observations at 67 Mc. The distributions cannot be represented by simple inverse power laws with constant exponents, s. For sporadic meteors, s increases from about 2.0 for faint meteors to 2.5 for brighter ones. For several showers, s also increases with brightness.

5036 Paper in Abstract 5032. "A Preliminary Report on Radar Meteor Counts," P. M. Millman and B. A. McIntosh (National Research Council, Canada), (9:1), Unclassified.

Description of a meteor patrol radar operated at Springhill Meteor Observatory near Ottawa for several years. The equipment operates on 32.7 Mc with peak power 20 kw; antennas are omnidirectional. Recorded mean hourly echo rates range from a diurnal minimum of less than 100 to a diurnal maximum over 400. A tendency is noted for the shape of the monthly mean diurnal rate curve to repeat itself in the same months for successive years.

5037 Paper in Abstract 5032. "The Harvard Radio Meteor Project," G. S. Hawkins (Harvard Observatory), (11:9), Unclassified.

Description of a multistation radar system for observing meteors. The system is capable of determining velocity, radiant, orbit, height, deceleration, and ionization distribution for individual meteors. Results are summarized for a total of 407 observations.

5038 Paper in Abstract 5032. "Meteor Rates Observed by Radio-Echo Techniques During the IGY-IGC Period," B. L. Kashcheyev and K. V. Kostylyov (Kharkov Polytechnical Institute and Kazan State University), (3:4), Unclassified.

Summary of results on meteor rates obtained at the Kharkov Polytechnical Institute over a period of several years. Graphs show diurnal and monthly variations of meteor rate.

5039 AFCRL-63-464, "Studies in Radio Astronomy and Space Physics," Apr 63, (134:-), Unclassified, AD 412 803.

A collection of 15 papers dealing with radio astronomy. Most have little to do with reflectivity. Of marginal interest is "A Presentation of Oblique Backscatter Soundings from Plum Island," C. Malik and R. Hartke (9:1), which summarizes results of several years of ionosphere backscatter observations. Two papers deal with scintillation of satellite or other signals traversing the ionosphere: "The Geomagnetic Control of Satellite Scintillations," J. Aarons (21:21), and "Scattering as Applied to Scintillation," J. Galloway (10:17). The latter is a Fourier treatment of diffraction of signals passing through an idealized ionosphere model.

5040 AFCRL-63-355 (Research Report), "Theoretical and Experimental Investigation of Backscattering from a Cavity-loaded Monopole," W. W. Gerbes and W. J. Kearns, Aug 63, (26:-), Unclassified, AD 422 863.

Discusses an approximate solution for the backscattering from a monopole (linear scatterer) grounded in a cavity. The solution was obtained for various

AIR FORCE CAMBRIDGE RESEARCH LABORATORIES (CONT.)

5040 (Cont.)

protruding lengths of the monopole and for various depths of the cylindrical cavity in the ground plane to which it was grounded. Backscattering was considerably reduced for a monopole protrusion not exceeding 0.45λ and for a cavity depth of approximately 0.25λ. To verify the solution, X-band reflection measurements were made using a CW, ground-plane measurement system; correlation between predicted and experimental results was quite good. The experimental arrangement is discussed briefly in an appendix.

5041 AFCRL-64-180 (Environmental Research Papers No. 8), "Automatic Digital Radar Reflectivity Analysis of a Tornadic Storm," D. Atlas, K. A. Browning, R. J. Donaldson, Jr., and H. J. Sweeney, Mar 64, (8:10), Unclassified, AD 442 178.

The advantages of a new radar digital processing device, called STRADAP, are demonstrated by a case study of the tornadic storm which struck Charlton, Massachusetts, on 12 October 1962. STRADAP furnishes patterns of echo height and maximum radar reflectivity in digital form, with a linear resolution of 5 sq. nmi and only a small time delay. It was used with a modified 3.2-cm AN/CPS-9 to produce print-outs showing a substantial increase both in reflectivity and in the area of the storm echo exceeding 40,000 ft. Other severe weather phenomena, such as strong winds, heavy rain, and lightning also correlated fairly closely with the STRADAP patterns.

Note: This document is reprinted from J. Appl. Meteorol. 2, 574-81 (Oct 63).

5042 AFCRL-64-181 (Environmental Research Papers No. 7), "Airflow and Structure of a Tornadic Storm," K. A. Browning and R. J. Donaldson, Jr., Mar 64, (13:15), Unclassified, AD 442 179.

Analysis of a thunderstorm that produced tornadoes near Geary, Oklahoma, on 4 May 1961, using data from a 10.7-cm RHI radar, a 10-cm PPI radar, and a 3.2-cm PPI radar. The storm configuration is compared and found to be remarkably similar to the severe Wokingham hailstorm in England (see Abstract 5418). Each storm attained a fairly steady state during which certain characteristic features were displayed. The authors suggest that the most important of these was the vault, a region of low reflectivity beneath the highest parts of the storm which is believed to be symptomatic of an intense and persistent updraft. Observations were also made of a "forward overhang," a region of relatively intense echo extending down over a region devoid of echo, and a "wall," a nearly upright leading edge of intense echo extending to the ground.

Note: This document is reprinted from J. Atmos. Sci. 20, 533-45 (Nov 63).

5043 AFCRL-64-182 (Physical Sciences Research Papers No. 6), "Back-Scatter by Dielectric Spheres With and Without Metal Caps," D. Atlas and K. M. Glover, Mar 64, (24:18), Unclassified, AD 450 644.

Backscatter from dielectric spheres with and without metal caps is approximated by methods of modified geometric optics using only three rays: the front axial, the rear axial, and the "glory" ray which exists when $\sqrt{2} \leq m \leq 2$, where m is the refractive index. It is stated that the latter two rays are responsible for the large radar scatter from plexiglass and ice spheres. When compared to the exact Mie solution for uncapped plexiglass spheres, the approximation is accurate in the range $5 \leq ka \leq 20$, where *a* is the sphere radius. At $ka > 20$, the approximation diverges from the Mie solution for some unknown reason.

AIR FORCE CAMBRIDGE RESEARCH LABORATORIES (CONT.)

5043 (Cont.)

Experiments were conducted with a bistatic CW system operating at 3.222 cm. Results with a rear metal cap, a front cap, and front and rear caps, for a plexiglass sphere with ka = 7, showed good confirmation both of the existence of all three rays and of the magnitudes of the predicted cross-sections. Experiments with melting ice spheres confirmed the interference between front axial and glory rays. Dielectric spheres with a rear metal cap and properly chosen constant refractive index and diameter were found to have cross-sections in excess of the Luneburg-lens reflector or flat plate of equal geometric area out to ka ≅ 20.

Note: This document is a reprint of a symposium paper, Abstract 8611J.

5044 AFCRL-64-250 (Physical Sciences Research Papers No. 8), "The Nonlinear Interaction of an Electromagnetic Wave With a Time-Dependent Plasma Medium," R. J. Papa, Apr 64, (36:34), Unclassified, AD 601 669.

A one-dimensional, inhomogeneous model is used to describe the nonlinear interaction of an rf plane wave with a time-varying plasma medium. A monochromatic wave is normally incident upon an electron-density profile whose gradients are shallow compared to λ. The electron energy relaxation time is much longer than the period of the wave, so that electron temperature does not follow the variations in the impressed field. The inter-electron collision frequency is much larger than the frequency for energy transfer between electron gas and neutral gas. The time-dependent response of the plasma medium may be found by numerically solving the energy-balance equations and the continuity equation for the electron gas. The spread in frequency of the electromagnetic wave field due to the time-varying electrical conductivity may be computed by employing the WKB approximation as a solution to the wave equation for a time-varying medium.

5045 AFCRL-64-475 (Environmental Research Papers No. 23), "Laser-Satellite Reflection Parameters," R. L. Iliff, Jun 64, (13:5), Unclassified, AD 605 270.

Several satellite shapes and types were examined as potential reflectors of laser radiation. Nomographs are presented which relate reflected energy as a function of satellite range, divergence caused by reflector assembly, receiver aperture, and laser divergence. Numerical values were assumed for the parameters of these satellite configurations. Calculations of the returned energy indicate that a corner reflector located on a satellite would reflect approximately 3×10^3 times as much energy as a diffusely reflecting spherical satellite, and also that a diffusely reflecting cylindrical satellite of relatively generous dimensions would not reflect sufficient energy to be detected above background noise.

5046 AFCRL-64-522 (Environmental Research Papers No. 26), "Generation and Properties of High Altitude Chemical Plasma Clouds," N. W. Rosenberg and D. Golomb, Jul 64, (14:15), Unclassified, AD 450 375.

Describes in detail a method of forming localized regions of high electron density in the upper atmosphere. A mixture of cesium nitrate, aluminum powder, and a high explosive is detonated in the region of the upper atmosphere between 90 and 120 km. The chemistry of electron clouds is treated in detail; propagation characteristics, and such topics as the life times and cross-sections of clouds

AIR FORCE CAMBRIDGE RESEARCH LABORATORIES (CONT.)

5046 (Cont.)

are only briefly discussed. Values of σ in the range of 10^6 to 10^8 m^2 and lifetimes up to about 3000 seconds are noted.

Note: This document is a reprint from Progress in Astronautics and Aeronautics, Vol. 12, Academic Press, 1963, and was presented as a paper at the ARS Ions in Flames and Rocket Exhausts Conference held in Palm Springs, California, from 10 to 12 October 1962.

5047 AFCRL-64-631 (Environmental Research Papers No. 39), "Radar Reflectivity of Storms Containing Spongy Hail," D. Atlas, K. R. Hardy, and J. Joss, Aug 64, (7:24), Unclassified, AD 447 316.

Experimental measurements of 5-cm wavelength show that the backscattering cross-sections of ice spheres, approximately 2 cm in diameter and coated with a mixture of water and ice (a "spongy" coating) are 3 to 4 dB above those of the equivalent solid ice spheres. Thus the extremely large reflectivity factor ($Z = 10^7$ mm^6 m^{-3}) observed at 3 cm for hailstones can be accounted for by concentrations of only about 3 gm/m^3 of 1-cm-diameter hailstones having a spongy coating. Either the falling away of the spongy coating upon melting or its freezing upon being lifted in the updraft will reduce reflectivity, thereby producing the maximum reflectivity observed at an intermediate level of the storm. The existence of spongy ice allows the surface and radar observations of hailstorms to be explained without any of the physically implausible assumptions of previous hypotheses.

Note: This document is a reprint of a journal article, Abstract 7756J.

5048 AFCRL-64-725 (Air Force Surveys in Geophysics No. 158), "Radar in Tropical Meteorology," R. J. Donaldson, Jr. and D. Atlas, Sep 64, (80:76), Unclassified, AD 450 524.

A brief history of radar meteorology is followed by detailed discussion of several composite hurricane models developed in a number of separate studies. Particular attention is given to three main structural features of the model: the outer "precursor" bands, the main rain shield or bands, and the eye defined by an intense echo wall. Each of these features is discussed with reference to past hurricane observations and delineated in an excellent collection (24 pages) of PPI- and RHI-scope photographs and graphs of data from radars whose wavelengths range from 3.2 cm to 10.7 cm.

Several theories of band formation are compared, and the eye structure and movement, the life cycle, and methods for quantitative radar measurements of hurricane structure are considered. Also discussed are contributions from radar research in tropical meteorology other than hurricane investigations, including several observations of tropical precipitation and thunderstorms.

Note: This document is a reprint of a paper presented at the Symposium on Tropical Meteorology, held at Rotorua, New Zealand, from 5 to 13 November 1963 and sponsored by the World Meteorological Organization and the International Union of Geodesy and Geology.

5049 AFCRL-64-727, Vol. I (Special Report 6), "The Modification of Electromagnetic Scattering Cross Sections in the Resonant Region. A Symposium Record, Volume I," J. K. Schindler and R. B. Mack, Editors, Sep 64, (173:-), Unclassified, AD 606 106.

AIR FORCE CAMBRIDGE RESEARCH LABORATORIES (CONT.)

5049 (Cont.)

This is the first of a two-volume collection of papers presented at a symposium held on 4 June 1963 at the Air Force Cambridge Research Laboratories. The twelve papers in the present volume hopefully established the need for techniques to significantly reduce the cross-section of bodies for wavelengths comparable to body size. Individual papers are abstracted below. Volume II is classified Secret; see Volume IX of this bibliography.

5050 Paper in Abstract 5049. "Some Thoughts on Scattering Cross Sections in the Resonance Region," R. B. Mack and P. Blacksmith, Jr. (AFCRL, Microwave Physics Lab), (8:6), Unclassified.

After introductory comments on cross-section concepts in the resonance region, backscatter cross-sections of several metal targets are compared and considered as having different shapes but about the same size.

5051 Paper in Abstract 5049. "The Minimization of the Backscattering of a Cylinder by Central Loading," Kun-Mu Chen and V. Liepa (University of Michigan, Radiation Lab), (32:5), Unclassified.

A theoretical and experimental study concerning minimizing the backscattering of a thin cylinder by central loading. The induced current on a centrally loaded cylinder illuminated by a plane wave at normal incidence is theoretically determined and experimentally measured. Magnitude and phase of the induced current can be greatly changed by a central impedance. Optimum loading to achieve zero backscatter in the broadside direction was determined for a thin cylinder shorter than 2λ; optimum central impedance for minimizing the broadside backscatter from a thin cylinder over a wide range of frequencies was also determined.

5052 Paper in Abstract 5049. "Backscatter Reduction of Long Thin Bodies by Impedance Loading," W. P. Hansen, Jr. (The Boeing Company, Aero-Space Division), (7:3), Unclassified.

Experimental vertification of an impedance-loading technique for reducing backscatter from long thin bodies. It is shown that significant reduction is possible while providing receiving capability. The body is thus converted into an antenna having a high ratio of receiving cross-section to backscatter cross-section under conditions of low backscatter. Using the Smith-chart representation of antenna scattering, the backscatter cross-section is evaluated for any load impedance at the frequency under consideration.

5053 Paper in Abstract 5049. "Theoretical and Experimental Investigation of Backscattering from a Cavity-Loaded Monopole," W. W. Gerbes and W. J. Kearns (AFCRL, Microwave Physics Lab), (17:1), Unclassified.

Note: See Abstract 5040 for the work reported in this paper.

5054 Paper in Abstract 5049. "Scattering from Thick Reactively Loaded Rods," C. J. Sletten, P. Blacksmith, F. S. Holt, and B. B. Gorr (AFCRL, Microwave Physics Lab), (20:4), Unclassified.

This paper examines the effectiveness of the three techniques of reducing σ for objects of resonant dimensions: shaping, coating with absorbing material, and passive reactive loading. Monostatic, bistatic, and bandwidth measurements are reported for targets of cylindrical shape and double conical shape. It was

AIR FORCE CAMBRIDGE RESEARCH LABORATORIES (CONT.)

5054 (Cont.)

concluded that coating elongated objects of length approximately $\lambda/2$ with absorbing material or shaping them into the double conical form does not significantly reduce overall peak σ. These two techniques have their greatest effect in reducing σ when polarization is vertical; under this condition the σ for an elongated object is already well below its overall peak value. When horizontal polarization is used, overall peak σ occurs and the two above techniques are least effective in reducing backscatter; under this condition reactive loading has its greatest effect. The three techniques thus tend to complement each other, and it is reasonable to expect that a combination of all three techniques should produce an object with good wideband minimum backscattering characteristics.

5055 Paper in Abstract 5049. "Analysis of Loaded Terminal Scatterers," E. M. Kennaugh (Ohio State University, Antenna Lab), (12:6), Unclassified.

Several concepts in the analysis of scattering by antennas, i.e., objects possessing one or more real or virtual terminal pairs are described. The effect of the load impedance upon antenna echo area, the dependence of average echo power on load reflection coefficient, and the analysis of arbitrary scatter as multi-mode antenna are all briefly considered. Antenna echo measurements were made with programmed load variations, in particular by a germanium switching diode and by a rectangular plate with a slot.

5056 Paper in Abstract 5049. "Some Bounds to the Behavior of Small Resonant Scatterers," R. F. Harrington (Syracuse University, Electrical Engineering Department), (4:3), Unclassified.

This paper characterizes small resonant scatterers by a gain-bandwidth product which is unchanged by losses, assuming that the current distribution on the scatterer is unchanged. The losses reduce echo area and Q but not gain-bandwidth product.

5057 Paper in Abstract 5049. "A Determination of the Scattering From a Cavity-Backed Plane Surface," J. K. Schindler (AFCRL, Microwave Physics Lab) and F. V. Schultz (Purdue University, School of Electrical Engineering), (15:3), Unclassified.

Analysis of the scattering from an idealized cavity-loaded structure consisting of an infinite plane backed by an infinitely long rectangular cavity and coupled through the plane by a narrow, infinitely long aperture parallel to the cavity axis. The fields are obtained by loaded and unloaded considerations, with the solution obtained by perturbation and integral-equation methods.

5058 Paper in Abstract 5049. "Some Concepts for Reducing Reflectivity From Antenna Apertures," E. M. Turner (Wright-Patterson AFB, AF Systems Command, Electromagnetic Environment Branch), (3:0), Unclassified.

Examples of techniques for concealing an aperture from radar detection. Configurations incorporate diode switches for a horn aperture, a conical spiral antenna, and a dipole antenna. A non-reciprocal ferrite in a waveguide is also shown.

5059 Paper in Abstract 5049. "Radar Cross Section of Perfectly Conducting, Dielectric and Dielectrically Clad Infinite Cylinders at Arbitrary Incidence," A. S. Thomas (A. S. Thomas, Inc.), (20:8), Unclassified.

AIR FORCE CAMBRIDGE RESEARCH LABORATORIES (CONT.)

5059 (Cont.)

The equations of incident, internal, and scattered fields at arbitrary incidence are presented here for an infinite cylinder consisting of N homogeneous, concentric, dielectric cylindrical layers. The expressions for the scattering coefficients for a single layer about a perfectly conducting core with an incident TM field ($H_z = 0$) are derived, and then the expressions for incident TE mode are given. These general expressions reduce to those for the solid homogeneous dielectric cylinder as well as for the solid metallic cylinder.

5060 Paper in Abstract 5049. "Effect of Surface Diffusivity Upon the Scattering Characteristics of a Plasma Sphere," P. J. Wyatt (Plasmadyne Corporation), (9:5), Unclassified.

The effect of varying the surface diffuseness of a spherical plasma region is examined in the resonance region. It is found that large changes in electron density may be readily compensated by modest changes in surface diffuseness where the scattering characteristics of such regions are concerned.

5061 Paper in Abstract 5049. "Absorption Resonance Effects in Plasma Spheres," N. Pedersen (AVCO Corporation, RAD Division) and L. Malmstrom (Harvard University), (19:1), Unclassified.

Describes theoretical work dealing with the absorption of electromagnetic power by homogeneous plasma spheres surrounded by a medium whose refractive index is near unity. Under these conditions, Mie scattering theory may be used to compute the absorption cross-section of the sphere as a function of its complex dielectric constant, its radius, and the frequency of the incident wave. Conditions for maximum power absorption efficiency are discussed. Strong absorption resonances are expected only when the ratio of sphere radius to λ is less than unity.

5062 AFCRL-64-753 (Environmental Research Papers No. 47), "A Study of Auroral Echoes at 19.4 Megacycles per Second," C. Malik and J. Aarons, Sep 64, (6:7), Unclassified, AD 450 478.

Description of a three-year study of auroral returns observed with a low-powered radar at a geomagnetic latitude of 54° north. Evidence is presented that auroral echoes reach a peak shortly after sunset throughout the year. It is suggested that the time of maximum auroral activity, the presence of reflections without magnetic storms, and the direction of echoes lead to the hypothesis that field-aligned ionization occurs during periods of magnetic field changes. The altitude of field-aligned variations was observed to be 200-400 km during quiet periods and 100 km during magnetic disturbances.

Note: This document is a reprint of a journal article (Abstract 7758J).

5063 AFCRL-64-756 (Physical Science Research Papers No. 49), "Radio Frequency Propagation Through an Inhomogeneous, Magnetoactive, Nonlinear Plasma Medium," R. J. Papa, Sep 64, (53:28), Unclassified, AD 607 901.

The Boltzmann equation corresponding to an electromagnetic wave propagating in a magnetoactive plasma is solved by making a spherical harmonic expansion of the electron distribution function. The problem of a plane, monochromatic wave normally incident upon a nonlinear, anisotropic, inhomogeneous plasma slab is considered. By using the Runge-Kutta numerical integration technique, it is

AIR FORCE CAMBRIDGE RESEARCH LABORATORIES (CONT.)

5063 (Cont.)

possible to compute the net reflection and transmission coefficients for a normally incident plane wave of arbitrary polarization. The elliptical wave is split into right and left circular modes. When the plasma is inhomogeneous in a direction perpendicular to the interfaces and the magnetic field is perpendicular to the interfaces, the right and left circular modes propagate independently of one another for a linear plasma medium. For moderate and high field strengths, the propagation characteristics of the right mode depend upon the amplitude of the left mode, and vice versa.

5064 AFCRL-64-784 (Physical Sciences Research Papers No. 50), "A Determination of the Electromagnetic Scattering from a Cavity-Backed Plane Surface," J. K. Schindler and F. V. Schultz, Sep 64, (104:23), Unclassified, AD 607 900.

Presents a theoretical solution for the scattering from an infinite plane surface backed by an infinitely long rectangular cavity. The cavity was assumed to be coupled through the plane surface by a narrow, infinitely long aperture running parallel to the axis of the cavity; also assumed was external excitation by a plane wave of arbitrary polarization and angle of incidence. The fields scattered by the structure consisted of the superposition of a field specularly reflected from the plane surface and a field re-radiated by the induced aperture fields. The far-scattered field excited by the non-zero aperture fields was calculated by applying the method of steepest descent to the field integrals; the spatial distribution of aperture fields was numerically calculated for various cavity dimensions.

5065 AFCRL-64-931 (Environmental Research Papers No. 70), "Radar Observations of Ice Spheres in Free Fall," J. T. Willis, K. A. Browning, and D. Atlas, Nov 64, (6:26), Unclassified, AD 454 894.

Simultaneous measurements were made of the radar cross-section and rate of fall of 5-cm (and larger) freely falling ice spheres observed by a high-precision 5.47-cm tracking radar. It was found that the decrease in radar cross-section accompanying the complete wetting of a freely falling sphere was only about half the 10-dB decrease previously reported for a stationary melting ice sphere. This was attributed at least in part to the thinner water film maintained about the freely falling sphere. It is pointed out that the absolute value of cross-section for a given thickness of water film is a rather sensitive function of wavelength, even though the positions of the maxima and minima are only a function of the diameter-to-wavelength ratio.

Note: This document is a reprint of a journal article, see Abstract 7310J.

AIR FORCE INSTITUTE OF TECHNOLOGY

5066 Report GAS-58-7 [?], "The Theory of an Omni-Directional Radar Reflector," E. M. Lipsey, 1958, (17:10), Unclassified, AD 161 836.

This report demonstrates analytically and experimentally that a true omni-directional radar reflector can be constructed from artificial dielectrics using the method developed for the construction of the Luneburg Lens. The construction techniques did not permit building of the entire lens; however that portion which was constructed gives a reflection of energy which is but 1.8 dB below that of the ideal sphere. The disadvantage of this loss is relatively insignificant compared to the advantages gained from the omni-directional qualities of the lens.

AIR FORCE INSTITUTE OF TECHNOLOGY (CONT.)

5066 (Cont.)

The theoretical technique applied to the omni-directional problem is a standard method of attack. A demonstration of the ease with which it may be applied to similar problems is given in an appendix where a solution to a class of lenses which will produce bistatic reflections is determined.

5067 M.S. Thesis GE-59B-20, "Plane Electromagnetic Wave Propagation and Reflection in Non-Absorbing, Inhomogeneous Media," F. S. Taylor, III, Sep 59, (32:16), Unclassified, AD 227 974.

A study intended to determine the reflectance of an inhomogeneous medium whose dielectric constant varies continuously across the entire medium. Modified wave equations are derived from Maxwell's equations and the properties of a plane electromagnetic wave. A wave-admittance function is derived and applied to determine a solution for electromagnetic fields in an inhomogeneous medium. Reflection of a plane wave in such a medium is investigated using Poynting-vector analysis and the Fresnel reflection coefficient at a boundary. It was concluded that a plane wave in a non-absorbing inhomogeneous medium does not suffer a loss of energy due to reflection. Further, a plane wave transmitted with normal incidence through the medium will not be reflected if the dielectric constant of the system is continuous.

Ed: These conclusions are sharply at variance with the results of most other investigations into reflection from inhomogeneous regions.

AIR PROVING GROUND CENTER, AIR FORCE SYSTEMS COMMAND

5068 AFAC-TN-57-46, "Use of Chaff to Determine Wind Velocity at Aircraft Altitude," E. P. Mechling, Jul 57, (18:4), Unclassified, AD 128 059.

Field tests were performed to determine an operational technique for measuring wind velocity and wind-layer dimensions at high altitudes by tracking chaff with radar. Specific objectives were to determine optimum chaff material, to develop satisfactory release methods, to ascertain how short tracking time might be while giving reliable data, and to develop usable procedures during tests conducted with jet aircraft. The chaff types used were RR-39/AL, RR-69 (XY)/AL, P36-339 and P36-338. The chaff clouds were tracked by a Nike X-band radar, and the balloon-borne radar reflectors were followed by an MSQ-1A S-band tracker. Askania photo theodolites were used for optical tracking. Good agreement between all methods was observed.

Rate-of-fall data showed that the rate over small time intervals is highly dependent upon the vertical air currents encountered. Rate-of-fall varied from 175 to 250 fpm for the same air-current characteristics. Significant conclusions were: (1) the use of chaff material for measuring wind velocity is entirely feasible; (2) P36-338 chaff is best because of its availability and higher dipole density; (3) the chaff puff-cartridge provides a reliable means of ejecting small amounts (50 gms) of chaff from high-speed aircraft; and (4) a 10-second chaff track is sufficient for measuring wind flow.

5069 APGC-TR-58-25, "Engineering Evaluation of the K-11 Honeycomb Dart Target," C. L. Jones, Mar 58, (12:-), Unclassified, AD 146 923.

The only radar information is the statement that performance was very good.

AIR PROVING GROUND CENTER, AIR FORCE SYSTEMS COMMAND

5070 APGC-TDR-62-28, "Testing Chaff," J. E. Bloomhuff and R. L. Grossel, May 62, (25:0), Unclassified, AD 277 054.

This report describes the concepts and methods of operational chaff testing followed at APGC. Four separate areas are covered: philosophy of testing; measurement techniques and instrumentation; data reduction and analysis; and statistical considerations. The philosophy section states that the primary objective of the range is to obtain quantitative measures of chaff characteristics at various frequencies independently of the measuring support radar. Chaff characteristics measured are response vs. time and frequency, rate of fall, and dispersion rate. A secondary objective is to determine specific effects of the chaff upon observing radars. The general areas discussed are: the requirements for properly making reflectivity measurements; procedure for measuring the time rate of chaff growth; and the determination of chaff break-lock capability.

The measurements section describes ground and airborne systems for obtaining chaff-bloom measurements. The ground system uses an MSQ-1A radar slaved to another MSQ-1A which is beacon-tracking the aircraft by con-scan. Video from the slaved MSQ-1A is applied to a camera and A-scope combination and to a video tape recorder along with sweep trigger and time marks. Absolute response levels can be obtained by: (1) comparison of return with standard reference pulses; (2) calibration curves of A-scope deflection vs. input power; and (3) the radar-range equation. Break-lock measurements are made by oscillograph recording of the range servo error voltage of the victim radar, and by comparison of digital range readings of victim and non-victim radars; the latter method is preferred.

5071 APGC-TDR-63-1, "Active Radar Augmenter Evaluation. A Validated Mathematical Approach," J. F. Kantak, Jan 63, (26:7), Unclassified, AD 296 071.

Briefly described is a technique for determining the radar cross-section of any active radar augmenter; also included is a five-step procedure for evaluating an active augmenter.

5072 APGC-TR-64-63, "Radar Reflectivity Measurements for AIM Series Missiles, 5-Inch HVAR Rocket, and 105mm Howitzer Projectile," P. E. Barnett, Sep 64, (45:-), Unclassified, AD 449 710.

Cross-sections of the AIM series missiles (AIM-4A, -4C, -4F, -4G, and -9B), 5-inch HVAR rocket, and 105-mm howitzer projectile were measured in the field at 1715 Mc, using vertically and horizontally polarized transmit-receive antennas. Raw data were converted to polar plots, shown in the form of dB relative to various reference levels. The AIM missile results show σ peaks exceeding 1.5 m^2, the HVAR σ peaks approach 2.58 m^2, and the 105-mm projectile peaks at about 0.1 m^2.

AIR WEATHER SERVICE (MATS)

5073 10WGM 55-1, "Use of Radar Meteorology in Flood Forecasting," 1 Jun 59, (33:8), Unclassified, AD 235 264.

The use of radar in flood forecasting is treated, and a number of factors are examined. These include: earth curvature, resolution, beam filling, attenuation, anomalous propagation, display non-linearities, blocking echoes, and second-trip echoes. The suspension of droplets by vertical currents and the dependence of radar reflectivity on drop size are suggested as contributing

AIR WEATHER SERVICE (MATS) (CONT.)

5073 (Cont.)

to a non-unique relation between radar-echo and rainfall intensities. Detection of snow by radar is also discussed.

5074 Final Report Phase 1959, "Project Tornado-Sferics," 23 Mar 60, (47:7), Unclassified, AD 240 489.

This report is mainly concerned with observations made with special sferics equipment. A comparison of these observations with radar-PPI photographs suggests that the merger of strong radar echoes may be significantly related to pronounced increases in the count of 10-kc sferics. A few PPI-scope photographs of tornado-producing squall lines are presented and discussed briefly.

5075 4WGP 105-2-7 (Final Report Phase 1960), "Project Tornado-Sferics," 20 Feb 61, (79:4), Unclassified, AD 254 827.

Concerns observations made with special sferics equipment. Only a brief comparison of sferics data is made with radar observations; no radar reflectivity information is presented.

5076 4WGP 105-10-1, "The Association of Thin Line Radar Echoes to Gust Fronts," A. C. Ramsay, 28 Jun 61, (19:5), Unclassified, AD 263 384.

An investigation of thin-line angel echoes observed at 3-cm on a CPS-9 PPI-scope. These echoes are attributed to a strong refractive-index gradient which coincides with the first gust line, produced by the cold, moist downrushing air from an approaching thunderstorm. Irregularities in the thin line are attributed to different surface frictions associated with cities, ridges, and valleys. The estimated velocity of the radar echo was found to agree closely to the gust velocities. Several PPI photographs of the thin-line echo are presented.

AIRBORNE INSTRUMENTS LABORATORY

5077 Final Engineering Report 3905-1 (AFCRC-TR-60-109), "Research Services on Moving-Target Indication," A. Nirenberg, E. Letscher, and P. Seckendorf, AF 19(604)-1731, Mar 60, (137:10), Unclassified, AD 234 747.

Detailed description of an accurate, high-rate system for recording and handling digital radar data. The system was designed to gather data on the physical and statistical characteristics of radar ground clutter. The information will be used to provide a basis for developing new and improved techniques and circuitry for MTI radar systems.

ALFORD (ANDREW) CONSULTING ENGINEERS

5078 Final Report (AFCRL-64-541), "Experimental Study of the Back Scattering from Conducting Objects in the Range of One Quarter to One Wavelength in Size," D. P. Flood and J. C. Field, AF 19(628)-2456, Apr 64, (50:7), Unclassified, AD 606 087.

The primary purpose of this program was to investigate the reduction in backscattering from objects effected by introducing reactive or other loading. A measurement system and procedure were developed for determining relative phase and magnitude of backscattered signals from test objects. The CW measurement system operated at frequencies from 600 to 1500 Mc. Targets were supported on a

ALFORD (ANDREW) CONSULTING ENGINEERS (CONT.)

5078 (Cont.)

platform of polystyrene foam approximately 12 ft from the front of the horn antenna (monostatic conditions). Measurements were made of a number of objects which were detuned by means of reactive loading. These included regular polyhedrons, dipole and monopole elements, cylinders, and planar structures. Backscattering cross-sections were reduced 15 to 20 dB or more at the frequency of minimum backscattering. Bandwidths obtained for some objects were on the order of 15% to 30% for 15-dB reduction in cross-section. Polar backscattering diagrams for most of these loaded objects are presented relative to a thin cylindrical rod having a resonant length of 0.438λ. Also included are measurement-system block diagrams, sketches, and photographs of the test objects. It is concluded that reactive loading could also be successfully applied to large two- and three-dimensional conducting objects to reduce backscattering.

ALLIED RESEARCH ASSOCIATES, INC.

5079 Final Report, Part III (AFCRC-TR-59-228), "Research in Radar Meteorology," R. J. Boucher and R. Wexler, AF 19(604)-3492, 20 Mar 59, (10:3), Unclassified, AD 220 568.

Only a small portion of this report contains information on radar reflectivity. It is shown that radar can follow rapid changes in the wind profile and can indicate significant trends. Study of 1.25-cm radar echoes from sea breeze suggests that the echoes are associated with atmospheric inhomogeneities producing strong refractive-index fluctuations.

5080 Scientific Report 3 (AFCRC-TN-59-615), "Methods of Presentation of Time-Height Reflectivity Profiles," R. Wexler, AF 19(604)-5204, Oct 59, (22:3), Unclassified, AD 230 234.

Two methods are considered for presenting vertical-reflectivity profiles, observed by a 1.25-cm APS-34 vertical beam radar. The first method is a plot of observed reflectivity with height at intervals of 5 minutes; the second is a plot of equal reflectivity lines on a diagram in which the ordinate is height, and the abscissa is cumulative frequency. Both types are presented with several THI photographs and a graph of reflectivity versus precipitation intensity.

5081 Scientific Report 6 (AFCRC-TN-60-451), "An Interpretive Code for the Weather Radar," R. J. Boucher, AF 19(604)-5204, 10 Feb 60, (24:7), Unclassified, AD 239 633.

An alpha-numeric code is described which is intended for communicating the essential non-transitory features of a radarscope from a radar site to a distant forecast center. No reflectivity information is included.

5082 Scientific Report 8 (AFCRL-62-486), "The Motion and Predictability of Amorphous Fields of Precipitation," R. J. Boucher and R. Wexler, AF 19(604)-5204, 1 Dec 61, (32:4), Unclassified, AD 282 252.

This report discusses the forecasting of motion of amorphous fields of precipitation echoes. In the technique employed, centroid positions and velocities are computed using data from 35-mm films of a 3.2-cm CPS-9 radar. It is demonstrated that the doubled average velocity of the centroid of such fields may be useful in extrapolating echoes for very short-range automated forecasts; however, forecast accuracy increases with the substitution of echo-element

ALLIED RESEARCH ASSOCIATES, INC. (CONT.)

5082 (Cont.)

velocity for centroid velocity, when automatic digital processing is not used. PPI photographs present examples of a precipitation line, a sharply defined leading edge, and an amorphous echo area. Histograms are given which represent a range of forecast intervals, with errors distributed according to percent of forecast period. Also included are graphic presentations showing probabilities that radar echoes will reach a given target area, for three different types of echo configurations.

5083 Final Report (AFCRL-62-487), "Weather Radar Research and Applied Techniques," R. J. Boucher, R. Wexler, and C. R. Shackford, AF 19(604)-5204, 30 Nov 61, (78:37), Unclassified, AD 282 347.

This report comprises seven independent studies of different aspects of weather radar research and applied techniques of short-range forecasting. Most of the radar observations were made with a 3.2-cm CPS-9 radar. Descriptions of the five studies that are pertinent follow.

"The Motion and Predictability of Precipitation Echoes," R. J. Boucher and R. Wexler, (9:5).

Objective techniques are outlined for using PPI radarscope information to forecast the onset of precipitation from echo lines, echo sheets with marked edges, and amorphous echo fields.

"The Estimation of Cloud to Ground Lightning by Radar," C. R. Shackford, (31:17).

By correlating PPI radar reflectivities of different thunderstorm levels with simultaneous surface observations of lightning, it is shown both that cloud-to-ground lightning production is related to the development of radar reflectivity between 15,000 and 25,000 feet, and that the probable amount of cloud-to-ground lightning in a given thunderstorm (up to about 10 strokes per minute) can be estimated from its three-dimensional echo structure. Lightning intensity and average profiles of radar reflectivity are graphed, and three-dimensional radar-echo features and occurrences of cloud-to-ground lightning are mapped.

"Radar Reflectivity Changes in Descending Hail," R. Wexler, (3:2).

This brief discussion of a theoretical investigation of the region of maximum reflectivity in thunderstorms offers hail growth in restricted size intervals as a possible contributing effect.

"Influence of Reflectivity Distributions Aloft on the Radar Detection of Precipitation," R. Wexler, (14:7).

The variation of radar reflectivity with range is determined and presented graphically for models of thunderstorms, hail storms, and tornado-producing storms, in a theoretical investigation of the radar detection of precipitation as it is influenced by both the vertical distribution of echo intensity and the intervening attenuation.

"Radar Cross Sections and Attenuations of Rain," R. Wexler, (11:6).

Cross-sections and attenuations from wavelengths of 3.2 cm to 10 cm, based on more accurate and systematic calculations from Mie theory, are tabulated for different empirical drop-size distributions.

ALTOSCAN COMPANY

5084 "Tethered Vertical Lift Device," Nonr-1691(00), Unclassified.

Bi-Mo. Report	Altoscan Report	Date	Pages	AD No.
2	116	Oct 57	7	408 787
4	118	Feb 58	21	408 788

Brief progress reports on development of a tethered flying device to hold up radar targets at altitude; no reflectivity data are involved.

AMERICAN METEOROLOGICAL SOCIETY

5085 Research Translation T-R-298+, "The Radar Method of Studying Sea Currents," I. S. Nikitin, AF 19(604)-6113, May 60, (5:1), Unclassified, AD 253 553.

A floating reflector is described, which can be tracked by radar in order to measure the velocity of sea currents. The target is 4 meters high and bears a metal-screen corner reflector. Calculation of correction for wind velocity is illustrated.

Note: Translation of: Meteorologiia i Gidrologiia, No. 4, 47-50 (1957).

5086 Research Translation T-R-402, "Radar Scattering by Non-Spherical Particles," A. B. Shupiatskii, AF 19(604)-6113, Mar 63, (23:8), Unclassified, AD 414 331.

Theory related to the approximation of radar scattering by small ellipsoidal particles is briefly reviewed and used to determine the magnitude of the echo signal and its depolarization. Scattering by randomly and nonrandomly oriented spherical and non-spherical water and ice particles was investigated. The following conclusions were reached: (1) horizontal polarization is best for detection of ice-crystal clouds consisting of horizontally oriented ice particles; (2) the return from ice-crystal clouds should increase when the radar antenna is directed vertically upward; and (3) the character of the reflecting particles may be determined by noting any change in return strength as the angle of polarization of the receiver is changed with respect to the angle of the transmitter; no significant change in intensity indicates the particles are either spherical in shape or are randomly oriented.

Note: Translation of: Tsentral'naia Aerologicheskaia Observatoriia, Trudy, No. 30, 39-52 (1959).

5087 Research Translation T-U-1+, "The Structure of Thunderstorm Showers, According to Data on the Intensity Distribution of Radarechoes With Height," M. L. Markovich and V. M. Muchnik, AF 19(604)-6113, Aug 63, (14:10), Unclassified, AD 421 984.

Describes a study of the physical nature of the change in echo intensity with height in thundershowers, from the ground to the level of maximum reflectivity. It was found that in the central portions of showers, the reflectivity usually changes considerably with height, increasing upward by a factor of 3 to 5 and sometimes 5 to 10; reflectivity does not, however, change appreciably with height on the periphery of a shower, where precipitation was light. Several processes are considered which may occur during the fall of hydrometeors in thundershowers and which might explain the observed large changes in reflectivity with height. Also discussed in some detail are reduction in drop size due to evaporation, accumulation of hydrometeors due to updrafts, fragmentation of drops

AMERICAN METEOROLOGICAL SOCIETY (CONT.)

5087 (Cont.)

reaching a critical size, and reduction in ice-particle size due to melting below the 0° C isotherm. It is concluded that the melting of hailstones during their fall is primarily responsible for the decrease in reflectivity below the bright band.

Note: Translation of: Ukrains'kyi Fizychnyi Zhurnal, Vol. 5, No. 2, 259-269 (1960).

ARMY ELECTRONIC PROVING GROUND

5088 "Communications by Re-Radiation from Chaff," Jun 60, (15:2), Unclassified, AD 243 085.

A theoretical method for maintaining communications well beyond the horizon by re-radiation or forward-scatter from radar chaff. The report is mostly concerned with communication-path loss and reliability of systems using chaff bounce above 30 Mc. However, various characteristics of chaff clouds are analyzed.

Note: This document is a reprint of a paper given at the Fourth National Convention on Military Electronics, June 1960.

ARMY ELECTRONICS LABORATORIES

5089 "Microwave Interaction with Plasmas," R. G. Buser and P. Wolfert, (9:6), Unclassified, AD 247 978.

Experimental measurements were made on the reflection and transmission of a microwave beam at 69 to 72 Gc from a high-energy plasma generated in a discharge tube with a magnetic field applied. Interest in the paper is focussed on the properties of the plasma, and there is very little material pertinent to radar reflections.

Note: This is a reprint of IRE Convention Record, Part 3, 146-54 (1960).

5090 USASRDL Technical Report 2110, "Radar Determination of the Surface Structure of the Moon," F. B. Daniels, 1 Apr 60, (7:4), Unclassified, AD 234 990.

A short analysis concerning the possibility of using radar experiments to obtain information about the structure of the lunar surface. The theory of radar reflections for a curved surface having random irregularities is developed and applied to radar echoes from the moon. The space-correlation function measured at the earth's surface was found to have a similar form to that of the lunar surface. Reasons are advanced for the choice of a Gaussian rather than a modified exponential function to represent the statistics of the lunar surface. The possibility of verifying the assumption by making space-diversity tests is discussed briefly.

5091 USASRDL Technical Report 2129, "The Angular Power Spectrum of Lunar Radio Echoes," F. B. Daniels, 25 May 60, (8:7), Unclassified, AD 239 464.

Work described in the previous abstract was continued. An expression for the angular power spectrum of the return signal (derived elsewhere by the author, see Abstract 7992J) is plotted and compared with experimental results of other workers. The fit is fairly good for the higher power-density levels near the center of the lunar disk, but near the limb the experimental curve appears to follow Lambert's law instead. The possibility is suggested of using simultaneous

ARMY ELECTRONICS LABORATORIES (CONT.)

5091 (Cont.)

pulse and fading measurements to determine the rotation rate of a planet. Results of both pulse and fading tests are interpreted as due to scattering from small-scale features of the surface.

5092 USASRDL Technical Report 2138, "Theoretical Evaluation of Cylindrical Chaff as a Wind Sensor at High Altitude," W. C. Barr, 22 Jul 60, (32:5), Unclassified, AD 241 876.

The equations of motion are examined for cylindrical chaff in the atmosphere between 60 and 90 km altitude (the free-molecule region), and between 30 and 60 km (the slip-flow region). Fall rate and chaff response to a step-function wind input are calculated, and it is concluded that the chaff is a reasonably good wind sensor below about 65 km. No data on reflection characteristics are included.

5093 USASRDL Technical Report 2163, "A Theory of Radar Reflections from the Moon," F. B. Daniels, Nov 60, (17:11), Unclassified, AD 247 077.

Previous work by the author (see preceding abstracts) is summarized, revised, and extended, using a theory of Feinstein ("Some Stochastic Problems in Wave Propagation," J. Feinstein, IRE Trans. Ant. Prop. AP-2, 23-30 (1954)). The approach uses Huygens' principle to sum the contributions of individual surface elements, taking into account phase differences due to large-scale curvature of the surface and to random height fluctuations. It is found that certain lunar surface parameters that are characteristic of the small-scale structure can be determined from measurements of radar-echo fading. These measured parameters are used to compute the angular power spectrum of the surface, and since the latter can be measured independently, an additional check on the theory is possible. Good agreement between theory and experiment was obtained for measurements made at 413 Mc. Results suggest a lunar surface pockmarked with telescopically invisible craters ranging down to an undetermined small size. See next abstract.

5094 USAELRDL Technical Report 2314, "Radar Reflection from a Planetary Surface Described by a Composite Correlation Function," F. B. Daniels, May 63, (13:20), Unclassified, AD 408 198.

Earlier work (see preceding abstracts) is here extended to include the case where the surface correlation function consists of two or more components. When both large- and small-scale structures are simultaneously present, it is found that the latter may completely dominate the autocorrelation function of the echo and thus render the former undetectable by CW methods. An additional finding is that the large-scale spectrum may be detectable in the angular power spectrum obtained from very short pulses as a separate "pip" at the origin; this has been experimentally confirmed. The effective radar gain of the surface derived from physical optics is not over unity, leading to a minimum value of 3 for the dielectric constant of the surface. The spectrum of surface fluctuations inferred from the dependence of surface slope on λ is found to have a gap for components having a scale on the order of a few meters. Shorter wavelengths demonstrate the existence of roughness having a scale on the order of a few centimeters or tens of centimeters.

5095 USAELRDL Technical Report 2437, "Review of Interactions Between Atmosphere and Wave Propagation," H. K. Weickmann, Mar 64, (20:45), Unclassified, AD 439 966.

ARMY ELECTRONICS LABORATORIES (CONT.)

5095 (Cont.)

A brief, concise review of broad aspects of interactions between the atmosphere and acoustic and electromagnetic waves, the latter encompassing light, infrared, and radar radiation. Such phenomena as scattering, absorption, refraction, and ducting are included. Effects on Army operational missions are particularly noted. An extensive reference section is given.

ARMY ELECTRONICS RESEARCH AND DEVELOPMENT ACTIVITY (WHITE SANDS MISSILE RANGE)

5096 Technical Report SELWS-M-4, "Performance Characteristics of Meteorological Rocket Wind and Temperature Sensors," N. J. Beyers, O. W. Thiele, and N. K. Wagner, Oct 62, (31:13), Unclassified, AD 286 254.

An evaluation of rocket-borne inertial systems, consisting of radar chaff, metallized parachutes, and temperature sensors, which were used to determine wind flow and temperature in the altitude range 50,000 to 250,000 ft. Fall velocities, parachute oscillations, chaff dispersion, and wind-sensor lag times were examined with radar and radiosonde ground equipment. The dispersion of chaff, which causes deterioration of signal return and inaccuracies in tracking, detracts significantly from its usefulness. Graphs of wind-measurement errors and typical wind and temperature profiles are presented.

ARMY ENGINEER RESEARCH AND DEVELOPMENT LABORATORIES

5097 Research Report 1721-RR, "Studies Concerning the Recognition of Subsoil Targets by Means of Microwaves," K. H. Steinbach and F. B. Varnum, 21 Sep 62, (87:13), Unclassified, AD 288 864.

This well-written report documents an experimental and theoretical investigation into the possibility of detecting buried land mines by means of microwaves. It is indicated that the chief difficulty is separation of target signals from signals caused by reflections from the soil surface or from soil inhomogeneities, rather than signal attenuation in the soil. A number of scattering patterns for an empty TMDB mine are shown. An experimental system is described which uses a pair of rotating horns and recognizes targets on the basis of their depolarization characteristics. A Doppler technique of cross-section measurement is described in which the target and a reference sphere are rotated and the Doppler return is examined; this greatly reduces the interference caused by return from walls or other nearby objects. (The technique has also been described elsewhere, see Abstract 7496J.)

ARMY FOREIGN SCIENCE AND TECHNOLOGY CENTER

5098 FSTC 381-T64-27, "Scattering of Elliptically Polarized Radio Waves by Nonspherical Atmospheric Particles," Yu. M. Gershenzon and A. B. Shupyatskiy, Oct 64, (10:6), Unclassified--For Official Use Only, AD 451 105.

Discusses theoretical problems involved in the use of elliptically polarized waves for the radar investigation of nonspherical cloud and precipitation particles. Water and ice particles are approximated by ellipsoids of revolution. The general expression for an echo signal scattered from a group of nonspherical particles is obtained for elliptical polarization; this result is then specialized to the cases of circular and linear polarizations. The advantages of the use of elliptically polarized radiation are demonstrated. It follows from the computations that, by a change in polarization parameters, it is possible to obtain

ARMY FOREIGN SCIENCE AND TECHNOLOGY CENTER (CONT.)

5098 (Cont.)

additional information on the form, orientation, and phase state of the scattering particles, using a single radar.

Note: Translation of: Tsentral'naya Aerologicheskaya Observatoriya. Trudy, USSR, No. 36, 102-108 (1961).

ARMY MISSILE COMMAND (REDSTONE ARSENAL)

5099 Report RE-TR-62-6, "Preliminary Evaluation of the Mini-Ball Target System," D. L. Kilbourn, 11 Mar 63, (18:0), Unclassified, AD 404 584.

A method is being developed of firing small metal spheres to serve as targets in field tests of guided-missile radar systems. Lead spheres have been fired from a bench-mounted .410-caliber shotgun, and proved to provide acceptable cross-section and velocity profile as targets for a radar on a frequency of 9.8 Gc. Tests with steel balls are under way.

5100 Report RF-TR-63-4, "The Reflection of Electromagnetic Radiation (Based on Classical Electrodynamics)," H. B. Holl, 15 Mar 63, Unclassified.

Volume	Title	Pages:Refs.	AD No.
I	---	128:23	422 882
II-App.	Tables of Radiation Reflection Functions	221:-	600 720

These two volumes present, in tables and graphs, numerical values of the Fresnel intensity reflection coefficients. Volume I includes background discussion on basic principles and the mathematical solution of the problem, together with a set of tables of reflectivity versus such parameters as incidence angle, index of refraction, and degree of polarization. Volume II comprises tables of reflection coefficients for normal and oblique incidence for approximately 2500 values of index of refraction $N = n - ki$, i.e., $n = 0.1(0.1)4.0$; $k = 0(0.1)6.0$; and angles of incidence $\theta_o = 0°(5°)85°$.

5101 Report RR-TR-63-14, "Diagnosis of Plasma Cylinders by Angular Scattering of Microwaves," R. L. Easley, 1 May 63, (69:26), Unclassified, AD 419 614.

Electron density and collision frequency of a plasma cylinder were studied by measuring the angular distribution of electromagnetic waves scattered by the cylinder. Instrumentation and measurement procedures are described in detail. A 20-kilowatt argon plasma jet having a DC arc formed a cylindrical plasma requiring no containing walls. Angular scattering distributions were measured at 35 and 72 Gc; a 72-Gc microwave interferometer provided an independent measurement of plasma properties. Predicted values for the magnitude and phase of the scattered field were obtained, using an IBM 7090 computer to solve the scattering problem for a homogeneous, infinitely long plasma cylinder having a range of electron densities and collision frequencies. The plasma jet was found to have a rapidly decreasing electron density as a function of radius. The value of angular scattering measurements in determining the properties of such inhomogeneous plasma cylinders is shown.

5102 Final Report RE-TR-63-23, "A Spectrum Compression Radar Technique," W. E. Wood, H. B. Buie, Jr., E. J. McManus, Jr., and W. H. Todd, 8 Aug 63, (55:31), Unclassified, AD 425 675.

ARMY MISSILE COMMAND (REDSTONE ARSENAL) (CONT.)

5102 (Cont.)

An experimental investigation was made of a radar technique characterized by: (1) transmission of a broad-band spectrum; (2) a stored version of transmitted waveform retained in the receiver; (3) introduction of a controlled, measurable time delay into the stored waveform; (4) removal of the modulation from the broad-band signal in the receiver; and (5) a resulting CW signal processed in a narrow-band filter. This "spectrum compression" radar is shown to perform the cross-correlation function which will yield range-rate and Doppler information. A simulator is described which will simulate 1 to 3 independently controllable targets, gross and fine Doppler, target noise environments from -20 dB to +10 dB signal-to-noise ratio, range, radar cross-section, and varying target scintillations. Theoretical analysis of the system fitted the experimental set-up very well. An appendix presents a simplified method of calculating Fourier transforms of waveforms applicable to this technique. Advantages of the spectrum-compression radar are cited for several military applications.

5103 Report RF-TR-63-16, "An Analytical Determination of the Radar Cross Section of Certain Missile-Like Configurations," R. J. Chynoweth and R. R. Boothe, 13 Aug 63, (34:3), Unclassified, AD 426 913.

The physical-optics method is reviewed as a means for determining the radar cross-section of bodies having certain missile-like configurations, and then illustrated by calculating the cross-section of a perfectly conducting sphere. Also presented are the first terms in the expansion of the physical-optics integral for various types of surface configurations which are considered in some cases to be valid approximations for the cross-section. Scattering by the cone-frustum is treated in some detail. Expressions for the cross-section are developed by considering each individual scatterer at specified aspect angles. Two methods for obtaining the total scattering cross-section are described: phase addition, which yields a complex pattern, and random addition, which yields an effective pattern. Appendices include expressions developed for the cross-sections of the cone at nose-on, the cone-cylinder-frustum, the cone-cylinder, and the blunted cone.

5104 Report RE-TR-65-1, "L-Band Clutter Measurements," E. M. Holliday, W. E. Wood, D. E. Powell, and C. E. Basham, 3 Nov 64, (30:2), Unclassified, AD 461 590.

Radar clutter was mapped in a brief study for an L-band (1340 Mc) site at Redstone Arsenal. The resulting clutter map shows primarily the effects of shadowing resulting from mountains and the magnitude of clutter from the terrain encountered. The cross-section per unit area $\sigma°$ ranged in value from -61 dB to 4 dB. Variations in the clutter were observed from day to day and even from hour to hour, the least amount of variation being associated with the mountainous terrain.

ARMY SIGNAL MISSILE SUPPORT AGENCY (WHITE SANDS MISSILE RANGE)

5105 Special Report 41, "Meteorological Rocket Wind Sensors," N. J. Beyers and O. W. Thiele, Aug 60, (32:9), Unclassified, AD 242 764.

This report concerns the determination of wind flow in the altitude range from 50,000 to 270,000 feet by observing the motion of rocket-borne radar chaff and metallized parachutes with radiosonde equipment and X-, S-, and C-band radars. Fall rates, parachute oscillations, chaff dispersion, parachute wind-response lag time, and signal strength versus slant range were examined. Results indicate

ARMY SIGNAL MISSILE SUPPORT AGENCY (WHITE SANDS MISSILE RANGE) (CONT.)

5105 (Cont.)

that the system provides adequate targets for SCR-584 and FPS-16 tracking radars over the altitude range for which Arcas and Loki rockets are used. It is reported that chaff provides an adequate wind sensor from about 140,000 to over 230,000 feet, although signal deterioration due to dispersion is about 20 dB per hour and accuracy is less than that with the parachute. Optimum signal strength is achieved by matching radar and chaff wavelength exactly, but adequate results are generally obtained from X-, S-, and C-band radar-tracking chaff cut to any length from 1.5 cm to about 5 cm.

AVCO CORPORATION, EVERETT RESEARCH LABORATORY

5106 Research Note 278 (AERL 62-30; AFBSD-TDR-62-5), "Survey of Scattering of Electromagnetic Radiation by an Ionized Gas," M. H. Rubin, AF 04(694)-33, Jan 62, (-:5), Unclassified.

(BD-2304) Scattering of electromagnetic radiation by plasmas is discussed with emphasis on analytic procedures which can be used to obtain order-of-magnitude estimates of radar cross-sections during re-entry. Maxwell's equations are expressed in terms of wave equations with suitable boundary values of the equivalent integral equation, and various simple models of the plasma configurations are made. For example, in an appendix, the one-dimensional problems of an exponentially increasing and linearly increasing conductivity are discussed in detail. It is argued that these problems are helpful in understanding scattering from a strong shock wave. The solution to the problem of reflection of a scalar wave from a rough one-dimensional surface is used together with the Kirchhoff approximation for reflection from a metal surface to estimate the cross-section of a cylinder with an overdense boundary layer. By crude models, estimates of the cross-section of laminar and turbulent wakes for both the overdense and the underdense casesare made.

5107 Research Report 127 (BSD-TDR-62-54), "Radio Echoes from the Ionized Trails Generated by a Manned Satellite During Re-Entry," S. C. Lin, W. P. Goldberg, and R. B. Janney, AF 04(694)-33, Apr 62, (63:26), Unclassified, AD 275 098.

The ionized trail produced during re-entry by the MA-6 Mercury capsule was observed from San Salvador Island approximately 370 miles uprange from the impact point; the apparatus employed was an omni-directional pulsed radar at 30.25 Mc. When the capsule was passing over the vicinity of the observation station, five clearly separated ionized trails were observed. The most prominent, which may be identified with the wake of the main capsule, was visible to the radar for a about 20 seconds, and displayed an equivalent isotropic scattering cross-section of about 10^6 m^2 at its peak. The other four trails, probably due to fragments of the disintegrating retro-rocket package, showed only short duration glints (on the order of one second) characteristic of the smooth, rapidly decaying trails of small meteors. While some of the fine structure of the long-duration, scintillating echo from the main capsule trail is not yet understood, the overall characteristics of the trail can be accounted for by a combination of high-light from a strongly reflecting front segment of the ionized wake, which appeared electromagnetically smooth to the 10-m wavelength employed, and diffuse scattering from a fully developed turbulent rear segment of the wake, which appeared rough to the wavelength. This suggests an explanation for the formation of "head-echoes" by large meteors.

AVCO CORPORATION, RESEARCH AND ADVANCED DEVELOPMENT DIVISION

5108 RAD-9-TM-60-37, "Multiple Scattering of Waves," P. C. Waterman, AF 04(647)-305, 21 Jul 60, (77:34), Unclassified--For Official Use Only, AD 242 705.

This theoretical study constitutes a fundamental theory of multiple scattering effects, restricted to fields describable by a single scalar potential; it concerns multiple scattering effects due to a random array of obstacles. Employing the "configurational averaging" procedure, a criterion is obtained for the validity of approximate integral equations describing the various field quantities of interest. The extinction theorem is obtained, and shown to give rise to the forward-amplitude theorem of multiple scattering. In the limit of vanishing correlations in position, the complex propagation constant of the scattering medium is obtained.

5109 RAD-TM-62-94, "Scattering of Electromagnetic Waves by Conducting Surfaces," P. C. Waterman, AF 04(694)-239, 19 Dec 62, (24:7), Unclassified--For Official Use Only, AD 403 322.

An exact formulation is given for computing radar cross-section and associated field quantities which arise when a perfectly conducting metallic shape is illuminated by an incident electromagnetic wave. The scattered wave is described by a surface distribution of electric dipoles, each of which gives a response proportional to the density of induced surface current at that point. The technique is equivalent to methods employing Green's theorem, but is free of the contingencies of the divergence theorem. Because this description is equally valid inside the surface, surface current may be determined by requiring the scattered wave to precisely cancel the incident wave inside. An infinite set of linear algebratic equations is then obtained. Equations are derived specifically for a conducting cone-sphere, and a computer-oriented solution is discussed.

5110 RAD-TR-62-13 (BSD-TDR-62-75), "Elementary Source Description of Scattering and Diffraction," P. C. Waterman, AF 04(647)-305, 2 May 62, (84:16), Unclassified, AD 223 676.

By examining the physics underlying boundary conditions of any diffraction problem, a description of scattering is obtained which employs elementary point sources distributed over the obstacle, and which is valid everywhere in space. The elementary source concept leads naturally to two kinds of integral equations for the determination of scattering. In the first, the unknown field for fixed incident plane wave is to be integrated over the surface or volume of the obstacle; in the second, the unknown field, at arbitrary fixed field point, is to be integrated over directions of incidence of an incident plane wave. This latter technique is most applicable to a class of obstacles meeting the geometrical requirement of enclosability. As an example of this method, the diffraction of an electromagnetic wave by an infinite strip is examined, and a solution obtained which is valid for low frequencies and for any direction of incidence normal to the axis of the strip. The theory developed provides new methods for exact computation of radar cross-section of many target types.

Note: This report was reprinted on 23 April 1963 as AD 425 508, and should be ordered by that number.

5111 RAD-TM-63-54, "Multiple Scattering of Waves with 'Hole Corrections,'" J. G. Fikioris and P. C. Waterman, AF 04(694)-239, 31 Jul 63, (22:8), Unclassified--For Official Use Only, AD 413 039.

AVCO CORPORATION, RESEARCH AND ADVANCED DEVELOPMENT DIVISION (CONT.)

5111 (Cont.)

Scalar multiple scattering in a random distribution of spheres is examined in this theoretical analysis. Certain results of the corresponding electromagnetic treatment are also included, but without derivation. In the treatment, transformation from a volume to a surface integral allows full account to be taken of "hole corrections" involved in the equation of multiple scattering. A specular equation is obtained for the propagation constant of the composite medium. In the low-frequency limit, ka $\ll$ 1, a new result is obtained which appears to be exact for all values of the fractional volume occupied by scatterers from 0 to 1. The corresponding procedure in electromagnetics gives an analogous result, which includes the Lorentz-Lorenz formula as a special case. Twersky's concept of "schizoid scatterers" (Abstract 7783J) is criticized. (See also Abstract 5113 below.)

5112 RAD-TM-63-78, "Exact Theory of Scattering by Conducting Strips," P. C. Waterman, AF 04(694)-239, 19 Dec 63, (29:11), Unclassified--For Official Use Only, AD 425 599.

Using the principle of superposition, a new kind of integral equation was developed to describe scattering by a conducting strip. The scattered wave was represented by a series of outgoing waves in circular cylindrical coordinates, which reduced the integral equation to an infinite set of linear algebraic equations; expansion coefficients could then be determined. Mathematical development was based on two factors: (1) any diffracting region can be characterized by a distribution of specific point sources throughout the region; and (2) the scattering region can be expanded by simply adding more material to obtain a new obstacle which can be treated by (1).

A specific problem treated was scattering from an infinite conducting strip due to incident plane electromagnetic waves with the propagation plane parallel to the plane of the strip axis. Equations were developed for the far-field phase and amplitude at normal and 45° oblique incidence for ratios of strip width to wavelength from 1 to 10. Plots of far-field amplitude and phase obtained from a computer program are presented along with curves obtained by the Sommerfeld and Kirchhoff approximations. Results show that as the strip width increases, agreement between the Kirchhoff, Sommerfeld, and superposition methods improves.

5113 RAD-TM-63-81, "Multiple Scattering of Electromagnetic Waves," J. G. Fikioris and P. C. Waterman, AF 04(694)-239, 27 Dec 63, (32:12), Unclassified--For Official Use Only, AD 426 193.

Previous scalar theory of multiple scattering in a random distribution of spheres (see Abstract 5111 above) is here generalized to vector problems. Vector equations are used throughout and full account is taken of "hole corrections." A secular equation is found for determining the propagation constant of the composite medium. In the low-frequency limit, results of the general theory are fully consistent with a "medium" description of the scattering region. Application of boundary conditions at the interface yields the effective μ and ϵ of the medium. This theoretical work has application in the analysis of artificial dielectrics used as radar absorbers, and in the computation of cross-sections of turbulent ionized re-entry wakes.

AVCO CORPORATION, RESEARCH AND ADVANCED DEVELOPMENT DIVISION (CONT.)

5114 RAD-TM-64-16, "Machine Calculations of the Radar Cross Sections of Infinitely Long Cylinders," C. R. Mullin, R. Sandburg, and C. O. Velline, AF 04(694)-239, 24 Apr 64, (30:8), Unclassified--For Official Use Only, AD 439 423.

A method was developed for calculating the scattering from an infinitely long cylinder of arbitrary but smooth geometrical cross-section. The scattering equations were programmed for a computer, and both monostatic and bistatic cross-sections were calculated for circular and elliptical cylinders. A number of checks and limiting cases are applied to the results to establish limits within which the assumed expansion gives acceptable numerical results. For monostatic scattering from circular cylinders, a numerical check is possible; the result agrees with Mie-series calculations to six significant figures.

5115 RAD-TM-64-61, "Exact Radar Cross Section of Axisymmetric Conducting Targets," P. C. Waterman, AF 04(694)-498, 11 Nov 64, (48:12), Unclassified, AD 451 196.

A method is proposed for computing radar cross-section and associated field quantities for a smooth, perfectly conducting target illuminated by an electromagnetic wave. The scattered wave is described by a surface distribution of electric dipoles, each of whose response is proportional to the density of induced surface current at that point. The surface current may be determined by the "boundary condition" that incident and scattered waves cancel exactly inside the target. A pair of coupled infinite matrix equations for the surface current is obtained. Green's identity permits the equations to be decoupled, reducing the problem to roughly the equivalent of two independent scalar problems. Equations are further specialized to axially symmetric targets, and several examples are solved on the IBM 7094. Reciprocity and energy conservation are also examined, and the resonant mode (interior) problem set up explicitly in matrix form. Experimental results at 35 Gc are in good agreement with theory.

BATTELLE MEMORIAL INSTITUTE

5116 Scientific Report 2 (AFCRC-TN-59-952), "Measurement of Complex Permeability and Permittivity of High-Loss Magnetodielectric Materials at Decimeter Wavelengths," A. Iwanovsky and G. J. Falkenbach, AF 19(604)-3046, 30 Sep 59, (14:22), Unclassified, AD 229 059.

Various waveguide methods of measuring complex permeability and permittivity for lossy materials were studied; all were found to be variations on the short-circuit, open-circuit technique of Birks (J. B. Birks, Proc. Phys. Soc. (GB) 60, Part 3, 282 (1948)). Each was found to be inaccurate for samples of appreciable thickness. It is concluded that all have the fundamental fault that they do not take into account losses introduced by higher-order modes when the material is exceptionally lossy and its thickness is not small compared to a wavelength.

BELL AIRCRAFT CORPORATION

5117 "The Application of Radar in Geologic Exploration," A. M. Feder, Mar 57, (18:0), Unclassified, AD 127 306.

In this document, the thesis is advanced that radar can be a useful tool in geological mapping and exploration. The appearance of various geological features on a PPI or side-looking presentation is described. All discussion is on an elementary level.

BELL TELEPHONE LABORATORIES, INC.

5118 Quarterly Progress Report 5, "Project Milcest," P. J. Bearer, B. A. Fairweather, et al., DA 36-039 SC-78261, 29 Feb 60, (75:-), Unclassified, AD 236 134L. (U.S. Military Offices may obtain copies directly from DDC; others request through USASRDL, Fort Monmouth, New Jersey, Attn: SIGRA.)

(DDC) The only pertinent section deals with battlefield surveillance techniques; the limitations of ground clutter on the detection of slowly moving, small-sized targets were evaluated for a conventional L-band pulsed radar set with a high-gain antenna and MTI circuitry using delay lines.

BENDIX CORPORATION, SYSTEMS DIVISION

5119 Report BSR-139, "Sea Clutter Investigations Using Oil Slicks," J. A. Busch, J. W. Crispin, R. G. DeLosh, et al., Nonr-2349(00), Oct 59, (155:18), Unclassified, AD 228 392.

The sea was studied with and without oil slicks to determine the relationship between the fine structure of the surface and sea clutter. The airborne CW Doppler radar system operated at X-band with vertical polarization and an antenna depression angle of 60°. Variables analyzed were amplitude distribution of the returned energy and Doppler frequency. Narrow-band spectrum analysis did not permit an oil slick to be discerned by measuring frequency. It was concluded that there are definite similarities between the nature of σ° for the clean sea and for a slick. The power amplitude (in dB) was observed to approximate a normal distribution for both, with clean sea data giving the better fit. No difference was found between the standard deviations, although it was hypothesized that the slick would have a value roughly one-half that for the clean sea. For wind velocities less than 8 knots, there was no appreciable difference between mean Dopplers for clean and slick sea. About 54 figures give either raw or analyzed data for many of the runs. Existing data of various investigators is summarized.

5120 Research Note 1, "The Plasma Sheath Effect on the Scattering Cross Section of a Hypervelocity Sphere. Part One. Introduction and Geometrical Optics Approach Using Ray Path Power Density Addition Technique," H. M. Musal, Jr., DA 11-022 ORD-2649, ARPA Order 39, 1 Dec 59, Unclassified.

(BD-235) Radar target characteristics of an object are expressible from the dynamic cross-section of the object. The dynamic cross-section of a hypersonic sphere differs from its static cross-section due to the presence of a plasma sheath surrounding the sphere and a plasma wake trailing behind the sphere. Under certain conditions sheath and wake effects can readily be separated. The sheath effect can be predicted approximately from the cross-section of a dielectric coated sphere. The cross-section of the latter is found via the geometrical-optics approach using ray-path power-density addition. Application of the results of this analysis shows that the nose-on dynamic cross-section of a hypersonic sphere varies both above and below the static cross-section of the sphere.

5121 Research Note 1, "The Plasma Sheath Effect on Radar Cross Section of a Hypersonic Sphere as Predicted by Lossless Geometrical Optics," H. M. Musal, Jr., DA 11-022 ORD-2649, NOrd-18930(FBM), and DA 11-022 ORD-3130, 1 Mar 60, (82:6), Unclassified, AD 268 800 or AD 424 331.

The purpose of this report is to show how the presence of a plasma sheath modifies the static cross-section of a re-entry body into the dynamic cross-section. Geometrical-optics techniques were used to obtain a first-order approximation of the plasma-sheath effect on the nose-on cross-section of a hypervelocity

BENDIX CORPORATION, SYSTEMS DIVISION (CONT.)

5121 (Cont.)

sphere. Upper and lower limits to the variations of the cross-section and characteristic transitional behavior can then be predicted on the basis of this first-order analysis. Since the power-density addition technique used averages interference phenomena, the results do not show scintillation effects arising from this cause; such effects must be predicted from a second-order approximation employing ray path field-intensity addition. On the basis of this second-order analysis, it is shown that the nose-on cross-section with plasma sheath may fluctuate from a maximum slightly greater than the static cross-section to a minimum of zero. The results of the geometrical-optics approach must be applied cautiously when the plasma dielectric constant closely approaches zero. Appendices present several aspects of electromagnetic wave reflection and transmission at plasma boundaries, and of scattering by a lossless dielectric-coated sphere.

Note: This report constitutes a portion of a paper "Plasma Effects on the Radar Cross Section of Reentry Objects," delivered at the American Rocket Society--Advanced Research Projects Agency Ballistic Missile Defense Conference held in Williamsburg, Virginia, 17-19 February 1960.

5122 Research Note 8, "Wave Propagation, Reflection and Transmission in a Lossy Semi-Infinite Cold Plasma," G. T. Flesher, DA 11-022 ORD-3130, ARPA Order 39, 20 Jun 60, (-:5), Unclassified.

(BD-1773) The nonlinear field equations describing microwave plasma interaction are linearized and wave solutions are found in a uniform plasma. Maps of the variation of the propagation constant, reflection coefficient, and transmission coefficient are plotted as functions of the plasma properties.

5123 Research Note 25, "Propagation and Reflection of Plane Waves in Plasma Having Inhomogeneity in One Direction," G. T. Flesher, DA 11-022 ORD-3130, 30 Jun 61, (21:4), Unclassified, AD 268 815.

Study of the behavior of electromagnetic waves in regions of space which have inhomogeneous distributions of electrons and ions. This analysis considers the steady-state reflection and transmission from a layered slab of plasma having inhomogeneity in one direction when it is irradiated normally with a plane wave. Several mathematical means are presented for finding expressions for the fields in the plasma. Integration of the currents to obtain the reflection and cross-section is not attempted.

5124 Research Note 36, "Radar Cross-Section of Low Electron Density Plasma Bodies of Arbitrary Shape," S. Zivanovic, DA 11-022 ORD-3130, 30 Jun 61, (16:3), Unclassified, AD 268 824.

The radar cross-section of arbitrary shapes of low-density plasma bodies for variable electron density is treated, and an approximation obtained for the case when the wavelength is much greater than the largest dimension of the reflecting body. Specific shapes considered are the sphere, cone, and cylinder. It is concluded that the cross-section of bodies of low-density plasma is always less than or equal to $N^2\sigma_e$, where N is the number of electrons in the cloud and σ_e is the radar cross-section of a single electron. This maximum is approached when λ is much greater than the cloud dimension in the direction of propagation.

BENDIX CORPORATION, SYSTEMS DIVISION (CONT.)

5125 Report FS-61TN-1013 (BSC-28251), "The Radar Cross Section of an Ionized Wake of a Hypersonic Body," C. M. Chu and D. T. Politis, AF 04(647)-911, 10 Nov 61, (25:2), Unclassified, AD 609 512.

Radar cross-section was estimated theoretically as a function of aspect angle, using the solution to Maxwell's equation for an inhomogeneous medium. Backscatter cross-section is determined as a function of aspect for a hypersonic sphere 1 ft in diameter at UHF and at L-, C-, and X-bands.

5126 Report FS-62TN-1026 (BSC-30221), "The Radar Cross Section of an Ionized Wake of a Hypersonic Body. III. Estimation of the Shielding Effect of a Body on Its Wake Radar Cross-Section," D. T. Politis, AF 04(694)-26, 12 Mar 62, (-:2), Unclassified.

(BD-2787) A first approximation to the radar cross-section of the wake of a hypersonic body has been derived, in which the presence of the body in front of the wake was ignored with the intention of evaluating the effect of its presence at a later time. It is the purpose of this note to estimate this effect and present correction factors on the previously calculated cross-sections.

BOEING COMPANY

5127 Mathematical Note 223, "A Graphical Estimate of Reflection from an Arbitrary Cylinder," T. P. Higgins, Oct 60, (13:-), Unclassified, AD 245 135 (DDC reference only).

(DDC) A quick approximate technique is given for determining the reflection from an arbitrary cylinder; it can treat any convex curve that can be drawn. For the particular question it proposes to answer it seems efficient, but it is worthless in providing a different kind of information. The graphical technique can be carried through analytically for any curve for which the equation is given. For a particular curve with numerical values for the parameters this is an elementary hand calculation procedure; a machine program based on a reverse procedure should be used for extensive calculations.

5128 Mathematical Note 232, "Reflection from Tumbling Targets. I. The Phase of Reflection from a Tumbling Slender Cylinder," T. P. Higgins, Jan 61, (9:-), Unclassified, AD 250 476 (DDC reference only).

(DDC) It would be desirable to employ radar to determine the orientation of a target as well as its position in space; tumbling information obtained from monitoring this orientation has many useful applications. This note outlines a method of determining instantaneous orientation of a target of known location by phase measurements.

5129 Document D2-20197-1, "Calculation of Reentry Vehicle Wake Cross Section," G. A. Clark, 15 Feb 64, (75:39), Unclassified, AD 468 544.

Radar cross-sections of the wakes of reentry vehicles are analyzed. Formulas are derived for predicting cross-sections of the far wakes, assuming a Gaussian radial variation of electron density; the near cross-section is discussed briefly. Wakes considered may be underdense, overdense, coherent, or incoherent. They may have radii large or small compared with λ, be of any length, and be viewed broadside or at oblique aspect. It is concluded that the reliability of predicted cross-sections is uncertain. However, for wakes encountered in practice, complete cross-section behavior can often be obtained with an accuracy of 3 dB.

BOEING COMPANY (CONT.)

5130 Document D3-4331, "Evaluation of Single Horn Reflection Techniques and Applications," W. Livingston, W. G. Louie, and C. W. Matthis, 16 Mar 64, Unclassified.

Note: This report was not obtained.

BROWN ENGINEERING COMPANY, INC.

5131 Technical Note R-1, "Parameters Influencing Radar Returns from Re-Entry Vehicle Wakes," H. C. Crews, Jr., DA 01-009 ORD-1019, 31 May 62, (34:18), Unclassified, AD 414 912.

Equations to describe electromagnetic wave propagation in a weakly ionized plasma are derived using Maxwell's equations and considering collisions. These equations are expressed in both electrical (permittivity and conductivity) and optical (index of refraction) terms. The dependence of plasma propagation properties on flow chemistry and aerodynamics is described, and a method is outlined which relates flow properties to propagation properties.

5132 Technical Note R-25, "A Model for Prediction of the Electromagnetic Interaction with the Wake of Re-entry Bodies," J. E. White, Jr., DA 01-009 ORD-1019, 15 May 62, (20:7), Unclassified, AD 414 819.

In this short mathematical treatise, an electromagnetic wave is assumed incident normally on a simplified model of a re-entry wake, and Maxwell's equations are solved to obtain expressions for the reflection coefficient with parallel and transverse polarization. A laminar wake is assumed, comprising three concentric, homogeneous, isotropic, cylindrical shells of weakly ionized plasma. The scattered field at the surface of the outer shell is found, and from this expressions for the cross-section are obtained. Numerical solutions have been generated but are not included in this report.

5133 Technical Note R-46, "Reflection and Transmission Coefficients for a Plasma Layer," J. M. Scarborough, DA 01-009 ORD-1019, Apr 63, (13:2), Unclassified, AD 414 894.

Reflection and transmission coefficients are computed for a plane electromagnetic wave incident normally on a plane-parallel layer of uniform lossy plasma of finite thickness. Results are expressed in dimensionless form in order to extend their range of applicability. It is found that for layer thicknesses small compared to λ, transmission should be appreciable even at frequencies below the plasma frequency. For values of $(\omega_p/\omega)^2$ less than about 0.1, the reflected power is very small for all values of normalized loss and thickness.

5134 Technical Note R-51, "A Numerical Method for Computing Transmission and Reflection Coefficients of an Inhomogeneous Plasma Layer," J. M. Scarborough, DA 01-009 ORD-1019, Jun 63, (25:14), Unclassified, AD 414 690.

Presented is a numerical method of computing reflection and transmission coefficients for inhomogeneous plasma layers when the gradient of inhomogeneity is normal to the surface of the layer. The method is applied to the specific problem of telemetry from a body re-entering the earth's atmosphere. The model neglects the effect of curvature of the plasma layer and assumes the incident wave is plane; the effects of induction fields near the telemetry antenna and the problem of antenna breakdown are also ignored. As an example, transmission and reflection coefficients are determined for the plasma sheath surrounding certain

BROWN ENGINEERING COMPANY, INC. (CONT.)

5134 (Cont.)

bodies during re-entry at an altitude of 80 km and at speeds of Mach 18 and Mach 30; a transmitting frequency of 240 Mc is assumed. Results indicate that failure to penetrate the Mach 18 sheath cannot be attributed to reflection or absorption by the plasma of the electromagnetic energy of the wave. At Mach 30, however, these effects would very likely preclude transmission at this frequency.

5135 Technical Note R-52, "A FORTRAN Program for Computing Reflection, Transmission, and Absorption Coefficients for an Inhomogeneous Plasma Layer," B. H. Kavanaugh, Jr. and J. M. Scarborough, DA 01-009 ORD-1019, Jun 63, (71:0), Unclassified, AD 421 181.

This report describes a FORTRAN computer program for calculating the transmission, reflection, and absorption coefficients of an inhomogeneous plasma layer. A modified Runge-Kutta integration scheme is used to solve Maxwell's equations for the electric and magnetic fields at the boundary of the plasma layer.

5136 Technical Note R-59, "A FORTRAN Program to Calculate Bessel Functions of Integral Index and Complex Argument," J. E. White, Jr., DA 01-009 ORD-1019, Jul 63, (31:5), Unclassified, AD 416 797.

Calculation of the radar cross-section for a cylindrical shell of plasma requires very accurate computations of the Bessel functions of the 1st, 2nd, and 3rd kinds with complex arguments and integral order. FORTRAN II subroutines for the IBM-1410 computer have been written to calculate these functions. The zeroth- and first-order results agree with ten-place tables prepared by the National Bureau of Standards; special methods are used to minimize round-off error in the recursive calculations of higher order.

5137 Technical Note R-111, "Scattering of Electromagnetic Waves from the Disturbance Caused by a Rapidly Moving Body in Plasma," S. K. Suh, DA 01-021 AMC-85(Z), Aug 64, (23:10), Unclassified, AD 606 290.

General theory of scattering of electromagnetic waves by a body moving in a plasma is developed in detail, using a perturbation method which furnishes a reasonably accurate differential cross-section under two different physical conditions. The general theory is extended to investigate scattering from the disturbance caused by a rapidly moving body in the ionosphere, and from the turbulent wake of a re-entry vehicle. In the first problem, kinetic equations are used to find the frequency spectrum of the electron density fluctuations in terms of which the differential scattering cross-section can be expressed. It is found that the scattering cross-section is strongly dependent upon the angle between the velocity of the body and the vector $(\vec{K} - \vec{K}')$, where $\vec{K}$ is the incident wave vector and $\vec{K}'$ is the scattered wave vector. In the second problem, the differential scattering cross-section is obtained in terms of the correlation function for turbulence.

Ed: Document cover bears title "Scattering of Electromagnetic Waves by a Low Density Plasma."

BROWN UNIVERSITY

5138 Technical Report WAL-143/14-49, "Multiple Scattering of Waves," P. C. Waterman and R. Truell, DA 19-020-505 ORD-3882 and DA 19-020 ORD-3650, Oct 57, (73:12), Unclassified, AD 146 492.

BROWN UNIVERSITY (CONT.)

5138 (Cont.)

Equations are obtained for the multiple scattering of waves in a homogeneous isotropic medium containing a statistical array of scattering regions. From these equations the microscopic properties of the "scattering medium" are derived in terms of the scattering properties of a single scatterer. The theory is extended to multiple scattering with mode conversion. Two applications are described: transmission of plane waves by a semi-infinite uniform array of spherical obstacles, and scattering by a random distribution of isotropic point scatterers.

5139 Scientific Report AF 4561/15, "The Scattering Cross Section of a Composite Cylinder I. Geometric Optics," R. D. Kodis, AF 19(604)-4561, Dec 61, Unclassified.

Note: This report was not obtained.

5140 "On the Solution of a Transcendental Equation Arising in the Theory of Scattering by a Dielectric Cylinder," W. Streifer and R. D. Kodis, AF 19(604)-4561, Unclassified.

Part	Scientific Report	AFCRL Report	Date	Pages:Refs.	AD No.
I	AF-4561/17	62-598	Jun 62	27:17	286 033
II		63-8	Aug 62	25:6	412 778

Asymptotic solutions are obtained for scattering by a dielectric cylinder in the first part of this study, assuming large values of ka (a = cylinder radius), such that the theory may be applicable to plasmas, meteor trails, and ionized columns. Graphs illustrate the path of the roots for different numerical values. In Part II, asymptotic series solutions are obtained for the transcendental equations which arise in the theory of scattering by obstacles large compared to wavelength.

5141 Final Report AF-4561/20 (AFCRL-65-100), "Study of Radiation and Propagation of Electromagnetic Waves," C. M. Angulo, AF 19(604)-4561, Feb 63, (40:-), Unclassified, AD 463 300.

This report contains only brief abstracts of work on a variety of topics investigated under the contract. Pertinent topics are: propagation in stratified regions (dielectric or ionized gas); diffraction by composite cylinders (dielectric or ionized gas); wave motion in an ionized gas; and interaction of fields and plasmas. References are given to papers published in the open literature on these topics.

5142 Scientific Report AF-2498/1 (AFCRL-63-318), "On the Scattering of Electromagnetic Waves by a Dielectric Cylinder," W. Streifer and R. D. Kodis, AF 19(628)-2498, Dec 62, (26:6), Unclassified, AD 418 708.

The scattering of polarized cylindrical electromagnetic waves by an infinitely long dielectric cylinder is mathematically analyzed, assuming the electric vector to be parallel to the cylinder. The Poisson sum formula is used to obtain the integral solutions rather than the Watson transformation method. Features of this study include: (1) more precise pole locations in residue computations, (2) treatment of a refractive index N less than one, and (3) numerical computations. A plot of normalized backscatter cross-section vs. normalized radius for N = 0.4 is given.

BROWN UNIVERSITY (CONT.)

5143 Scientific Report AF-2498/2 (AFCRL-63-344), "Diffraction by Composite Cylinders," M. A. Akcoglu and R. D. Kodis, AF 19(628)-2498, Jun 63, (96:27), Unclassified, AD 420 911.

Considers diffraction by a cylindrical obstacle of two-dimensional monochromatic waves with magnetic vector parallel to the cylinder. The obstacle is a perfectly conducting core surrounded by a dielectric coating of arbitrary shape which may be lossy, inhomogeneous, or anisotropic. The field is determined by using an integral equation. Perturbation theory is used to obtain solutions for cases which deviate by small amounts from exactly solvable boundary-value problems; a specific example yields the radiation pattern of a slot antenna. Numerical examples are chosen to be of particular value for theoretical study of a plasma sheath.

5144 Report Nonr(562)35/4, "Waveguide Analogies of Scattering and Propagation in Inhomogeneous Plasma," L. Wetzel and L. G. Cohen, AF 19(628)-2498 and Nonr-562(35), Jul 64, (27:8), Unclassified, AD 606 981.

Conditions are found under which dominant-mode propagation in a lossless tapered waveguide may serve as an analogue of plane-wave propagation in a lossless inhomogeneous plasma. These conditions are relatively mild, thereby permitting a suitably tapered waveguide to serve as an analogue computer for determining field distributions and reflection and transmission coefficients for plasmas having fairly arbitrary density profiles. The analogy is demonstrated by experimentally determining the reflection coefficient for a linear plasma profile. Analogies based on the use of an inhomogeneous dielectric in a uniform waveguide are discussed briefly. It is found that such analogies are suitable for measurements only at a single frequency and therefore have limited practical value.

CALIFORNIA INSTITUTE OF TECHNOLOGY, ANTENNA LABORATORY

5145 Technical Report 11 (AFOSR-TN-57-300), "Electromagnetic Scattering Properties of a Resonant Plasma," H. Shapiro, AF 18(600)-1113, (59:23), Unclassified, AD 132 371.

A column of ionized mercury vapor was created in a discharge tube in a parallel-plate transmission line and the reflection coefficient was observed at frequencies ranging from about 180 to 700 Mc. Plasma resonance was found at only one value of discharge current, and theoretical calculations are advanced to support this observation, which is contrary to the results of other investigators. The bulk of this report is devoted to a fairly detailed summary of the mathematical theory of plasma columns and of scattering from them. The initial treatment assumes a uniform plasma density, and makes the common assumptions neglecting ion motion and magnetic forces. The non-uniform case is then discussed, and results are obtained by approximate solution of the differential equation assuming a radial dependence of electron density.

5146 Technical Report 28 (AFOSR-3016), "A Theoretical Study of the Scattering of Electromagnetic Impulses by Finite Obstacles," W. P. Brown, Jr., AF 18(600)-1113, Jun 62, (-:25), Unclassified, AD 282 745.

(BD-4260) A general approach to the solution of pulse scattering by finite obstacles. The essential feature is identification and separate treatment of the individual terms in a wavefront expansion of transforms of the field vectors. It is demonstrated that the dispersive effect of a finite conductivity in the

CALIFORNIA INSTITUTE OF TECHNOLOGY, ANTENNA LABORATORY (CONT.)

5146 (Cont.)

scattering obstacle can be neglected for all metals, but that it may be significant for poorly conducting materials such as dry earth. The wavefront technique is employed to solve problems of the transmission of a delta pulse through a conducting dielectric slab and the reflection and diffraction of a delta pulse from a perfectly conducting sphere. The transmission-problem results provide a convenient example of the usefulness of the wavefront approach. Results for the sphere problem indicate that the waves observed at a given spatial point change in time. It is shown that the penumbra and the caustic region in the vicinity of the focal line $\theta = \pi$ are initially of zero extent. Rates of expansion of these regions with increasing time are obtained by considering error terms in asymptotic expansions of the fields. Temporal behavior of near and far field zones is similarly obtained.

5147 Technical Report 30, "Theory of the Scattering of Electromagnetic Waves by Irregular Interfaces," K. M. Mitzner, AF 49(638)-1266, Jan 64, (126:50), Unclassified, AD 436 811.

Analysis of two problems involving electromagnetic scattering from irregular interfaces, considering both deterministic and statistical irregularities. In the first case, geometrical optics is used to study reflection of a partially polarized plane wave from a plane interface with large irregularities. Matrix transformations relating incident and reflected waves are obtained for reflection both from a single point and from an extended area containing many independent reflectors. The properties of a wave reflected from a diffusely illuminated rough interface are found and used to study reduction of reflection noise when a polarization-sensitive detector viewing near the Brewster angle is used in infrared temperature measurements. Secondly, the method of small perturbations is used to study scattering of an arbitrary, completely polarized wave from an irregular interface of general underlying shape. The irregularities are replaced by equivalent surface currents and then the field in space is found using the dyadic Green's functions of the unperturbed problem. Results are valid when the irregularity has small slope and an amplitude small compared to wavelength and to total radius of curvature.

CALIFORNIA INSTITUTE OF TECHNOLOGY, JET PROPULSION LABORATORY

5148 Technical Release 34-54, "A Lunar and Planetary Echo Theory," W. E. Brown, Jr., NASw-6, 30 Apr 60, (32:3), Unclassified, AD 240 772.

A relatively simple statistical approach is used to derive a theoretical response of the lunar surface to an incident impulse. The solution contains only one open parameter, k, a characteristic of the surface roughness. A value for k is found by comparing theoretical behavior with experimental results reported by Trexler (Abstract 8147J); the same value appears to be consistent with data from Goldstone and Millstone experiments. The echo is assumed to consist of specular and scattered components, and the ratio of total scattered power and total specular power reflected is found to fall between 0.1 and 1.0. Actual scattered power is then compared with the theoretical Lambert cross-section and the average reflectivity determined to be about -20 to -26 dB. In order to aid the discussion of lunar surface properties, assumptions of conductivity and permeability are made; resulting relative permittivity is approximately 1.3. Depth of the surface layer, based upon a theoretical interpretation of Pettengill's data (Abstract 8166J), could be as great as 10 km.

CALIFORNIA INSTITUTE OF TECHNOLOGY, JET PROPULSION LABORATORY (CONT.)

5149 Technical Note 3 (AFOSR-1506), "Reflection and Transmission of Electromagnetic Waves at Electron Density Gradients," F. A. Albini and R. G. Jahn, AF 49(638)-758, Oct 60, (107:11), Unclassified, AD 419 466.

Solutions for the propagation of plane electromagnetic waves normal to a gradient of free electron density are obtained in the form of complex Airy functions. Reflection and transmission coefficients are derived for normal incidence on a linear ramp of electron density connecting a uniform dielectric gas with a uniform ionized gas, as functions of ramp length and propagation exponent of the latter. Computer applications and evaluations are discussed. Also studied are two-stage ramps of variable proportions, intended as a second approximation to smooth-profile transition zones. In each case, reflection and transmission coefficients depend strongly on ramp width over a range of several tenths of a wavelength, and then oscillate mildly toward the asymptotic values predicted from a WKB approximation. The results are less sensitive to the detailed shape of the profile.

Note: This report comprises 86 graphs and 21 pages of text.

5150 Technical Report 32-132, "Radar Exploration of Venus: Goldstone Observatory Report for March-May 1961," W. K. Victor, R. Stevens, and S. W. Golomb, Editors, NASw-6, 1 Aug 61, (103:33), Unclassified, AD 263 012.

Experimental results of the Venus radar probe conducted in 1961. The 2388-Mc radar system is thoroughly discussed. Measurements indicated the relative dielectric constant of Venus to be 3.6, the surface roughness to be similar to that of the moon, and the surface reflection coefficient to be approximately 0.097; the planet's rotation was also treated. Accuracy of the astronomical unit was extended by the work, and the radar cross-section was determined to be 11% $\pm$ 2% of the geometric cross-section. Some conjectures are made for extending the technique to observation of other planets.

5151 Technical Report 32-199, "Scientific Experiments for Ranger 3, 4, and 5," NASw-6, 5 Dec 61, (25:10), Unclassified, AD 269 878.

The various scientific experiments intended to be performed by the Ranger 3, 4, and 5 spacecraft are described. One of these is the measurement of the radar reflectivity of the lunar surface, to be accomplished by monitoring the strength of the return to the pulse-radar altimeter. Discussion of this experiment includes brief comments on the state of our knowledge of the lunar radar reflectivity from earthbound measurements.

CANADIAN ARMAMENT RESEARCH AND DEVELOPMENT ESTABLISHMENT

5152 Technical Report 507/64, "A Microwave-Plasma Interaction Model to Study the Head-On Radar Cross Section of Blunt Bodies under Reentry Conditions," M. Gravel and M. Waymel, ARPA Order 133, Aug 64, (16:10), Unclassified, AD 449 712.

Describes a physical-optics model being developed to study the influence of the plasma sheath on the head-on radar cross-section of blunt bodies. According to this model, the large variations in cross-section observed experimentally in hypersonic ranges with small metal spheres would be mainly the result of interference between the signal reflected at the vertex from the surface of the opaque region of the sheath and the signal reflected from the part of the sphere's surface not covered by opaque plasma. As the velocity of the sphere increases, the opaque region spreads over the surface to produce Fresnel interferences that

CANADIAN ARMAMENT RESEARCH AND DEVELOPMENT ESTABLISHMENT (CONT.)

5152 (Cont.)

are successively destructive and constructive until the sphere is completely eclipsed by overdense layers. Cross-sections of a one-inch aluminum sphere and a nearly spherical projectile are shown as a function of velocity at frequencies of 35 and 70 Gc; pressures of 75 mm Hg and 10 mm Hg were used.

CASE INSTITUTE OF TECHNOLOGY

5153 Scientific Report 3 (AFCRC-TN-59-192), "Higher Order Mode Properties of an Array of Parallel Metallic Plates," R. E. Collin, AF 16(604)-3887, 23 Apr 59, (28:5), Unclassified, AD 215 823.

In order to study the properties of a strip artificial dielectric medium, the reflection and transmission coefficients, both dominant and higher-order mode, were determined at the interface between free space and an infinite array of equi-spaced parallel plates. The study is limited to the case in which the total magnetic vector is parallel to the plates. The problem is solved by means of a bilateral Laplace integral and direct construction of the required transform. Some representative reflection and transmission coefficients were computed, as a function of the angle of incidence, for a plate spacing of 0.25λ at a wavelength of 3.14 cm. Only five terms of the infinite product expansion were used, which gave sufficiently good accuracy for the dominant mode computations but only fair accuracy for those at the higher-order mode. The results of these calculations are presented in three graphical plots.

5154 Scientific Report 11 (AFCRC-TN-60-380), "Scattering of a Plane Wave on a Ferrite Cylinder at Normal Incidence," W. H. Eggimann, AF 19(604)-3887, 25 Feb 60, (23:3), Unclassified, AD 237 887.

Scattering of a plane wave from a homogeneous ferrite cylinder was studied theoretically for normal incidence; the ferrite rod was assumed to be magnetized along its axis. Approximate formulas for the thin cylinder and the far field were developed. It was found that the field was asymmetrical with respect to the direction of the incident field. For certain values of the parameters, the scattered field has the form of a spiral wave, due to the precession of the magnetic dipole currents.

5155 Scientific Report 19 (AFCRL-TN-60-1169), "A Note on Waveguide Image Techniques," R. E. Collin, AF 19(604)-3887, 30 Nov 60, (18:0), Unclassified, AD 250 931.

Floquet's theorem and the reflection symmetry properties of Maxwell's equations are used to establish the relation between scattering by two-dimensional periodic structures in free space, and equivalent waveguide problems. For such structures as strip gratings, having only unidirectional periodicity, it is shown that the free-space problem is equivalent to the sum of two waveguide problems, and vice-versa. For structures with periodicity along two axes, four waveguide problems must be solved to determine the complete solution of the free-space problem. Only when more than one basic cell of the periodic structure is contained within the waveguide walls will a single waveguide problem be equivalent to the free-space problem as far as dominant mode fields are concerned.

5156 Scientific Report 20 (AFCRL-29), "Study of Control of Aperture Fields," AF 19(604)-3887, 9 Jan 61, (30:-), Unclassified, AD 252 550.

CASE INSTITUTE OF TECHNOLOGY (CONT.)

5156 (Cont.)

Short three-month progress summaries are given for several studies. Those pertinent are as follows. "Electromagnetic Diffraction of Circular Disks," (4:2). Previous work on diffraction of a plane wave by a circular perfectly conducting disk was extended to the case of an arbitrary primary field. "Anisotropic Properties of Artificial Dielectric Media," (1:1). Two sentences describe experimental and theoretical work on strip-type artificial dielectric media.

5157 Scientific Report 21 (AFCRL-77), "Higher Order Evaluation of the Diffraction of Electromagnetic Fields by Circular Disks," W. H. Eggimann, AF 19(604)-3887, 31 Jan 61, (148:56), Unclassified, AD 256 746.

Analytical investigation into the diffraction of an electromagnetic field by a perfectly conducting circular disk. A power-series solution in ka is given for the problem of a small circular disk with an arbitrary incident field. The surface-current density on the disk was calculated up to the third order approximation in ka. From these results, expressions for the induced electric and magnetic dipole moments were derived. The developed formalism was applied to the case of an incident plane wave. Formulas for the field radiated from an electric dipole lying in the plane of the disk and a magnetic dipole lying perpendicular to it were also derived. The results were applied to a quantitative analysis of the diffraction of a plane wave by a rectangular array of circular disks or the equivalent problem of a disk-loaded waveguide. The input susceptance of the waveguide is presented graphically for several different cases of approximations. Comparisons of calculated values with experimentally obtained values indicated that the power-series calculation method was accurate to within 10% for $ka < 0.75$.

CENTER FOR NAVAL ANALYSES, OPERATIONS EVALUATION GROUP

5158 OEG Study 644-A, "Echo Variability and the Formulation of a Radar Theory," 9 Mar 61, (34:2), Unclassified, AD 286 670.

The effect of variations in cross-section upon radar detection range is discussed and results of an experiment are presented. Two aircraft flew formation, so as to present a 425-Mc ground radar with dual targets at equal range sharing the same propagation path and holding nearly the same aspect. The returns from these targets were highly correlated, and the mean return of each exhibited long-term undulations on the order of 10 to 20 dB, with superimposed random fluctuations of similar size. While the return from each target exhibited high scan-to-scan correlation, the fluctuations, relative to a moving average, are independent scan-to-scan. This suggests that the frequently assumed Markoffian scan-to-scan dependence is not valid. It is concluded that gross variations in detection range, often attributed to operator factors, may derive in large part from target and propagation-path factors.

5159 Interim Research Memorandum 24, "A Method for the Theoretical Determination of the Radar Cross-Section of Aircraft," R. J. Budnitz, 24 Sep 62, (14:2), Unclassified, AD 288 677.

A method is proposed for calculating theoretically the cross-section of aircraft with the aid of a digital computer. The suggested technique is a variation upon one advanced by the University of Michigan (see Abstract 6219). The gross form of the aircraft is simulated by a collection of simple geometrical shapes, such as to provide an analytic piece-wise-continuous mathematical

CENTER FOR NAVAL ANALYSES, OPERATIONS EVALUATION GROUP (CONT.)

5159 (Cont.)

description of its form in three-dimensional space. (Excluded from this modeling are various special features, such as resonant structures and dihedral angles, which must be treated separately by other means.) The description of the model is stored in a digital computer, expressed relative to an arbitrary coordinate system. A grid is assumed, normal to the direction of travel of incoming radiation for a desired aspect angle, where the grid dimensions are small relative to a wavelength. The computer samples each block of the grid in turn, and determines if a parallelepiped erected normal to that block intersects the model. If so, the computer selects the nearest of the surfaces intersected (thereby taking care of shadowing) and computes the return from an elemental flat plate oriented tangential to the center of the intersected element of the front surface. The total return from the model is taken as the vector sum of all such elemental returns, from whence the cross-section is derived.

CENTRALE METEOROLOGICA SVIZZERA, OSSERVATORIO TICINESE (SWITZERLAND)

5160 Technical Note 1 (AFCRL-63-760), "On the Backscattering of Mixture of Ice and Water," J. Joss and R. List, AF 61(052)-559, Sep 63, (4:-), Unclassified, AD 424 125.

The radar cross-sections of spongy ice spheres, made in a hail tunnel, were measured with a 5.05-cm radar. The measurement procedure is described and results are compared with earlier studies. It is tentatively concluded that hailstones consisting of a sphere of ice with a shell of spongy ice give the same cross-sections as spheres in which all the ice is concentrated in the inner part and all the liquid water in the skin.

Note: Translation of: J. Appl. Math. and Phys. 14, 376-80 (1963).

CENTRO RADIOELETTRICO SPERIMENTALE, G. MARCONI (ITALY)

5161 Scientific Note 1 (AFCRC-TN-59-574), "H. F. Backscatter from Land and Sea," I. Ranzi and P. Dominici, AF 61(052)-139, 30 May 59, (6:6), Unclassified, AD 228 115.

Backscattered echoes from land and sea, propagated via the F_2-layer of the ionosphere, were studied at 18.6 and 22.3 Mc using stations near Rome, Italy. Results show a 360° azimuthal distribution with a primary maximum on the Atlantic Ocean and a primary minimum on the African continent. The secondary maximum corresponds to the Mediterranean Sea and the secondary minimum to Russia. Ranges out to about 5000 km were obtained, and the same general distribution was observed independent of station locations at two coastline orientations and in a flat plain. A Yagi array with an azimuth beamwidth of 56° was used, and the minima were sometimes obscured by short-range backscattering from the sea occurring in this wide beam.

5162 Scientific Note 2 (AFCRL-TN-60-953), "Tropospheric Influence on H.F. Backscatter Near the Sea," I. Ranzi, AF 61(052)-139, 30 Mar 60, (7:1), Unclassified, AD 242 801.

In connection with ionospheric studies between 2 and 7 Mc, strong echoes have been observed at distances from 20 to 100 km. A vertical dipole transmitted 100-μsec pulses at 4 Mc from the coast near Rome, Italy, and strong echoes were obtained by direct backscatter at ranges of 60 and 85 km. A vertical-loop antenna was used for receiving at various points and these strong echoes were identified

CENTRO RADIOELETTRICO SPERIMENTALE, G. MARCONI (ITALY) (CONT.)

5162 (Cont.)

as coming from a promontory 635 m high and an island. Diurnal variations of over 15 dB were observed, with a midday maximum. Day-to-day variations may reach 10 dB. Observations at 7 Mc using a vertical dipole show these diurnal variations also. The tropospheric mechanism responsible for the increase in direct backscatter is being investigated (see next abstract).

5163 Scientific Note 3 (AFCRL-736), "Experiments on Backscatter of H.F. Radiowaves from Open and Coastal Sea," I. Ranzi, AF 61(052)-139, 1 Mar 61, (11:3), Unclassified, AD 268 083.

Backscatter from the sea surface and coastal features was observed with long-pulse (5 to 50 μsec) radars at 4, 7, 10, and 28 Mc. Measured Doppler shift of echoes from the open sea verified the results of Crombie (Abstract 3243J) and Dowden (R. L. Dowden, "Short-Range Echoes Observed on Ionospheric Recorders," J. Atmos. Terr. Physics 11, 111-17 (1957)) that radio waves propagated parallel to the motion of sea waves of length $n\lambda/2$ will be coherently backscattered. For the most intense backscatter (n = 1), the Doppler shift is given by $\Delta f_D = (g/\pi\lambda)^{\frac{1}{2}}$.

An "apparent" voltage reflection coefficient is defined; its maximum value for rough seas was about the same at 4 and 28 Mc. For calm seas, the mimima are about ten times as large on 28 Mc as on 4 Mc; this is interpreted as showing the appreciable effect of small undulations on the surface. At 28 Mc, a change from vertical to horizontal polarization decreased sea echo 40 dB, of which 14 dB is attributed to lower field strength at some unspecified height over the sea. With propagation of 4-Mc waves along the coastal sea, echoes from a 635-m promontory about 60 km away were found to undergo periodic fading in amplitude (without phase variation) at the predicted frequency. It is hypothesized that stationary waves are being formed near the coast and that the fading is due to periodic oscillation of the sea at the antinodes.

Echoes at 4 Mc from the coastal sea were greater than from the open sea. Bistatic echoes assumed to come from islands exhibited large increases of amplitude and fading with sea roughness. On 28 Mc and vertical polarization, echoes from an island showed the type of fading described above. The absence of echoes from the open sea at the same range as those observed from the coastal sea shows the strengthening of coastal sea echoes at this frequency also. The apparent reflection coefficient of a lake at 28 Mc was two orders of magnitude lower than that of the sea for the same order of roughness.

5164 Scientific Note 4 (AFCRL-911), "Backscatter of H.F. Radio Waves from Coastal and Continental Ground Reliefs," I. Ranzi, AF 61(052)-139, 15 Apr 61, (9:3), Unclassified, AD 268 075.

The work on Doppler shift of sea return was extended to 420 Mc and the predicted value observed. The return from ground reliefs near the sea has been studied further at 28 Mc. A 635-m promontory at a range of about 17 km across a coastal sea was observed to give a stronger echo on horizontal polarization than on vertical. At the same time, horizontal polarization eliminated the sea return. Variations in incident field strengths on the mount do not seem to explain this polarization effect; observations of a similar topology over land gave opposite results. Ground return from features beyond a sea surface was consistently 8 dB stronger than that from similar features observed over low terrain. It is remarked that the reflection of these reliefs may be due primarily to the top edges and that

CENTRO RADIOELETTRICO SPERIMENTALE, G. MARCONI (ITALY) (CONT.)

5164 (Cont.)

the irregular ground surface depolarizes the reflected wave more than the sea surface and thereby makes horizontal polarization more efficient.

5165 Scientific Note 5 (AFCRL-912), "Backscatter Sounding during Ionospheric Storms," I. Ranzi and P. Dominici, AF 61(052)-139, 15 May 61, (15:6), Unclassified, AD 268 084.

Ionospheric sounding by means of ground backscatter was examined using records at 18.6 and 22.3 Mc from the Torrechiaruccia station near Rome, Italy. Records of severe ionospheric storms during the period August 1957 to February 1961 are considered in detail. The technique provides a reliable and simple way to follow, on a large scale, the evolution of ionospheric disturbances and ionospheric phenomena in general. The observation that echoes from the less-disturbed zones showed greater intensity and extent during an ionospheric storm may be explained by the more complex structure of the ionosphere along these directions; the matter requires further study.

5166 Technical Note 5, "Doppler Frequency Shift of H.F. to S.H.F. Radar Waves Returned from the Sea," I. Ranzi, AF 61(052)-139, 15 Sep 61, (4:0), Unclassified.

Previous measurements of Doppler shift of coherent backscatter from sea waves at lower frequencies are here extended to 58 and 415 Mc using a phase-measuring device. The Doppler shift may also be measured by determining the frequency of beats between transmitted and backscattered waves. Recorded beat periods agreed satisfactorily with the predictions of 1.97 and 0.48 sec for 28 and 415 Mc, respectively. An observed amplitude modulation on the beat waveform may be due to intermittent short wave trains which produce coherent backscatter. At 6.8 Gc, beats with a period of 0.09 sec were observed with vertical polarization, but none at all with horizontal. The predicted Doppler would have a period of 0.119 sec at this radio frequency, corresponding to sea waves of length 2.2 cm. These would be capillary waves whose velocity varies with wavelength rather than square root of wavelength as do gravity waves, hence the discrepancy. Beats at 415 Mc and 6.8 Gc were best observed with slight seas; the signal had many irregularities with rough seas. The intensity of backscattered echoes at 28 Mc increased with sea roughness, but sea conditions had little effect at 415 Mc.

5167 Technical Note 7 (AFCRL-1127), "An Error Cause in Ionospheric Sounding Near the Sea," I. Ranzi, AF 61(052)-139, 15 Sep 61, (4:2), Unclassified, AD 277 982.

Sea waves can produce coherent backscatter of radio waves (particularly in the frequency range 1 to 6 Mc) which can interfere with ionospheric measurements. Unless the radiation pattern gives an unusually low field strength along the surface, echoes from the sea can cause confusion with weak ionospheric echoes at the same apparent range. Echoes from the coastal sea have deep periodic fading with no phase variation, while those from the open sea have great variability that does not appear to be simply correlated to surface conditions. Care must be taken in interpreting echoes from sounders closer to the sea than about 30-50 km.

5168 Technical Note 8 (AFCRL-1128), "Backscatter Echo-Pattern and Vertical Radiation Diagram," I. Ranzi, AF 61(052)-139, 1 Oct 61, Unclassified, AD 277 983.

CENTRO RADIOELETTRICO SPERIMENTALE, G. MARCONI (ITALY) (CONT.)

5168 (Cont.)

Ground backscatter propagated via the ionosphere has been observed at 18.6 Mc using horizontal Yagi antennas. An antenna was mounted successively at λ and 2λ above the sea, so that elevation angle of the radiation minimum of the higher antenna corresponded to the angle of the radiation maximum of the lower one. The distribution of ground backscatter via sporadic E showed distributions of intensity corresponding to the different vertical radiation patterns. Two sounders with antennas mounted 1.44λ and 3.38λ above the sea were operated simultaneously and the backscattered echo patterns reproduced the field-strength distributions over the backscattering zone. This technique allows the virtual height of the reflecting layer to be determined accurately, as well as aiding in the identification of the ground zone producing the backscatter.

5169 Technical Note 9 (AFCRL-62-395), "Sporadic-E Ionization Observed by the Backscatter Technique," P. Dominici, AF 61(052)-139, 15 Feb 62, (15:4) Unclassified, AD 283 084.

Description of ionospheric sounding of sporadic-E ionization at 18.6 and 22.3 Mc using the technique of ground backscatter. Discussed are seasonal and diurnal occurrence, as well as azimuthal distribution, as observed from stations near Rome, Italy. Correlation between the time occurrence of E_s echoes and E_s ionization is given. Movement and size statistics of E_s clouds are described: about 60% of the clouds were moving, 60% of these primarily toward the southwest and the mean dimension of the clouds was about 250 km.

5170 Final Technical Report (AFCRL-63-101), "Radiocommunication by Backscatter," I. Ranzi, AF 61(052)-139, 31 Dec 62, (17:10), Unclassified.

This final report summarizes most of the results given in previous reports, and extends and interprets them in some cases. Work was primarily done at 4 to 28 Mc. The research program concerned direct or ionospherically propagated signals backscattered from the ground, and was aimed at determining the influence of the nature of the ground on the intensity of the echoes and at identifying the factors causing broadening of backscattered pulses propagated via the F_2-layer. Direct line-of-sight and ionospheric-propagated backscatter were studied, and it was shown that large amounts of backscatter and pulse broadening occur near coastal boundaries and from highly developed regions having metallic structures such as railways and power lines. Increased bandwidth of a communication system utilizing ground scatter might be obtained by using antennas with narrow vertical beamwidths. The ionospheric irregularities producing multipath effects are of the focussing type whose occurrence increases with latitude.

Note: Two other reports also issued contain brief summaries of little value: Technical Summary Report No. 1 (AFCRC-TN-60-154), AD 233 836, 1 Jul 58 to 30 Nov 59; and Annual Summary Report No. 2 (AFCRL-913), AD 268 101, 1 Dec 59 to 31 May 61.

5171 Technical Report (AFCRL-64-108), "Backscatter of Radio Waves From Ground and Sea," I. Ranzi, AF 61(052)-665, 31 Jan 64, (7:3), Unclassified, AD 434 680.

This is the first report on a continuation of a previous program (see preceding abstracts). It has been confirmed that ground backscatter echoes spread more than normal at the sides of ionospheric storm zones. The increase

CENTRO RADIOELETTRICO SPERIMENTALE, G. MARCONI (ITALY) (CONT.)

5171 (Cont.)

in backscatter intensity is attributed to an increase in F_2 focussing irregularities around the perturbed zones. Backscatter records at 14.2 and 18.6 Mc have been compared with vertical soundings and, while a detailed correlation could not be made, there was coincidence between the two records for days having the greatest frequency of irregularities. Movement of F_2 irregularities was studied, and riometer measurements are being made of ionospheric opacity at 31.5 and 58 Mc.

CHALMERS UNIVERSITY OF TECHNOLOGY, RESEARCH LABORATORY OF ELECTRONICS (SWEDEN)

5172 Report US 21 (AFCRL-748), "A Theory of Incoherent Scattering of Radio Waves by a Plasma in a Uniform Magnetic Field," D. T. Farley, J. P. Dougherty, and D. W. Barron, AF 61(052)-451, 1961, (46:19), Unclassified, AD 271 735.

A general expression is derived for the frequency spectrum of radio waves scattered by random thermal fluctuations of electron density in a plasma under thermal equilibrium with a magnetic field present. The derivation is based on the generalized Nyquist noise theorem. The exact result is then simplified by means of an approximation which amounts to assuming the velocity of light to be infinite; this approximation is shown to be quite adequate for ionospheric applications of the theory. Next it is proved without approximation that the magnetic field cannot alter the total scattered power but only redistribute this power over the spectrum. Finally, the detailed shape of the frequency spectrum of the scattered signal is examined. Analytic expressions are given for certain limiting cases, but numerical methods must be used for the case of most interest. From these results, it can be seen that the magnetic field has a significant effect on the shape of the spectrum only if the incident radio beam is very nearly orthogonal to the magnetic lines of force.

5173 Report US 24 (AFCRL-62-123), "Scattering of Electromagnetic Waves by an Anisotropic Medium," K. H. B. Wilhelmsson, AF 61(052)-451, 1961, (22:8), Unclassified, AD 274 725.

The scattering of electromagnetic waves from an anisotropic homogeneous medium is analyzed theoretically for two geometries. In the first study, plane radiation is incident at arbitrary angle on the plane surface of the medium with magnetic vector parallel to the surface. The dielectric constant in directions normal to the surface differs from that parallel to the surface in the plane of incidence. A generalization of the Brewster angle is defined for the anisotropic medium: the reflection coefficient is zero for an angle of incidence such that the direction of the polarization vector in the medium coincides with the direction of the reflected plane wave as determined by the law of reflection. In the second case, plane waves are obliquely incident on an infinitely long cylinder, within which dielectric constant and permeability in the axial direction differ from those prevailing perpendicular to the axis. Separate treatments are made with magnetic and electric vectors of the incident wave orthogonal to the plane of incidence defined by cylinder axis and Poynting vector.

5174 Report US 28 (AFCRL-63-637), "Dynamic Non-Linear Wave Propagation In Ionized Media. 3. Electromagnetic Non-Linear Interaction and Reflection from a Plane Ionized Medium," O. E. H. Rydbeck, AF 61(052)-451, 1963, (44:5), Unclassified, AD 414 919.

CHALMERS UNIVERSITY OF TECHNOLOGY, RESEARCH LABORATORY OF ELECTRONICS (CONT.)

5174 (Cont.)

Study of the reflection properties of an isotropic ionized medium in the presence of non-linear effects produced in the medium by a separate, very powerful "pump" wave, of frequency f_p. If a primary signal of frequency f_o impinges on the disturbed medium, to first order, waves of frequencies f_o, $f_o + f_p$, and $f_o - f_p$, are returned from the layer. It is shown that the sum and difference waves may be very much enhanced by non-linear (parametric) resonances. When conditions for degenerate parametric resonance of the difference wave exist, the medium acts as a parametric amplifier, and the amplified wave is returned in the incidence direction with power provided by the "pump" wave.

The theory is extended in approximate form to the practically important, but very difficult, case of a slowly varying, inhomogeneous medium, in order to show how the secondary waves leave the interaction region. Results are of a fairly general nature, despite the fact that magneto-ionic effects are excluded.

5175 Report US 30 (Research Report 31; AFCRL-62-969), "Dynamic Non-Linear Wave Propagation in Ionized Media. 5. Reflection of Electromagnetic Waves from an Ionized Stream in the Presence of a High Power Primary Wave," K. H. B. Wilhelmsson, AF 61(052)-451, 1962, (62:9), Unclassified, AD 298 565.

The electromagnetic interaction of an ionized stream with two incident plane waves of different frequencies is studied theoretically, with particular reference to lowest-order mixed-frequency components. One of the two incident plane waves is assumed to propagate perpendicularly to the direction of the drift velocity, whereas the other wave is allowed to have an arbitrary angle of incidence. An infinitely strong magnetic field in the direction of the drift velocity is also assumed. The investigation covers the planar and cylindrical cases; the possibility of resonances of the mixed-frequency field components is demonstrated.

5176 Report US 31 (Research Report 32; AFCRL-62-968), "Dynamic Non-Linear Wave Propagation in Ionized Media. 6. Scattering of Electromagnetic Waves by an Anisotropic Medium with a Harmonically Time-Varying Dielectric Tensor," K. H. B. Wilhelmsson, AF 61(052)-451, 1962, (63:3), Unclassified, AD 298 299.

Results of previous work on scattering from anisotropic media (Abstract 5173 above) are extended to include the case where the components of the dielectric tensor describing the anisotropic medium have harmonically time-varying components (the "pump frequency") superposed on their static values. Studied in some detail are properties of the side-band frequencies representing sum and difference of the signal and pump frequencies. Also investigated are modification of the field at the signal frequency caused by interaction of the sidebands with the pump-oscillations; i.e., a kind of feed-back effect which is of second-order magnitude in the harmonic fluctuations of the medium. Planar and cylindrical cases are studied separately. It is demonstrated that the parametric resonance effect may cause a strong reflected signal. Laws determining the angles of reflection and refraction for the different kinds of waves entering the problem are discussed.

5177 Technical Note US 37 (Research Report 43; AFCRL-64-672), "Dynamic Non-Linear Wave Propagation in Ionized Media. 12. Electromagnetic Wave Reflection From an Oscillating, Collisionfree Magneto-Ionic Medium," O. E. H. Rydbeck, AF 61(052)-451, 1 Jul 64, (47:2), Unclassified, AD 607 090.

CHALMERS UNIVERSITY OF TECHNOLOGY, RESEARCH LABORATORY OF ELECTRONICS (CONT.)

5177 (Cont.)

Detailed treatment of electromagnetic wave reflection from a pumped magneto-ionic medium and from a slowly varying inhomogeneous medium. Reflection and refraction laws are developed for the mixed frequency components. It is shown that non-linear resonance effects can be used to echo-sound the ionosphere at mixed frequencies in the 25-Mc range to obtain the true height of reflection (at the difference frequency) and the electron-density gradient. Pulse powers of the order of 5 MW would have to be used for the purpose.

CHRYSLER CORPORATION, MISSILE DIVISION

5178 Report SAE-TN-17-62 (BSD-TDR-62-57), "A Study of the Interaction of Electromagnetic Waves with the Plasma Surrounding a Re-Entry Vehicle," M. Berman, AF 04(694)-25, 13 Apr 62, (66:15), Unclassified, AD 283 543.

The interaction of an electromagnetic wave with a plasma is analyzed. Initially, general equations are derived for the dielectric constant, propagation function, and conductivity of a plasma, after which the attenuation and reflection characteristics of a homogeneous, semi-infinite, uniform plasma slab are determined. The analysis treats reflection properties both without a magnetic field present, and with a uniform longitudinal magnetic field. The material is all theoretical, and the results of the first part are general.

5179 Report ADB-TN-37-62 (BSD-TDR-62-381), "A Preliminary Investigation of Suitable Techniques for the Expression of Static Radar Cross Section Signatures," S. A. Raggio and E. R. Staszak, AF 04(694)-25, 15 Dec 62, (57:4), Unclassified, AD 453 133.

A useful analysis of techniques for describing static radar cross-section signatures. Smoothing techniques are examined and two statistical concepts are derived which reflect the characteristics of a dynamic environment. One statistical approach uses a time-variant expression based upon knowledge of the initial attitude bias and precession rate of a separated re-entry vehicle. Another approach represents the bias and precession as a distribution about a nominal aspect angle, thereby making it time-independent. Both representations are intended for use in performing detection analyses in a dynamic flight environment. In addition, the aspect-angle statistical method appears to be an attractive basis for comparing static cross-section characteristics. A statistical representation was compared with an averaging representation for a dynamic environment utilizing a generalized dynamic detection model. It is concluded that a statistical model of a static radar cross-section more realistically reflects the presence of peaks and nulls in the signature, thereby enabling a better analysis of detection in a dynamic environment.

COAST GUARD

5180 "Sixth International Technical Conference on Lighthouses and Other Aids to Navigation," 26 Sep 60, Unclassified.

Pertinent papers obtained from this conference are abstracted below.

5181 Paper in Abstract 5180. "A Classification of Radar Reflectors in Use at Present," (Trinity House, England; Research and Development Section), (17:-), Unclassified, AD 242 001.

COAST GUARD (CONT.)

5181 (Cont.)

The effective range of seamarks bearing radar enhancement devices was investigated; results are summarized, along with a classification of the various types of reflectors being used in 1960. It was found that few basic types of reflectors were in use, but the size of reflectors varies considerably among different countries. The basic trihedral reflector has good characteristics as a floating seamark, but is difficult to manufacture and not easily combined into the shape of a buoy. The dihedral-trihedral reflector is not as efficient a reflector, but is easier to construct and can be included in the superstructure of a buoy. For land use the dihedral is obviously the best choice. The various types and variations of reflectors are tabulated according to country and radar cross-section. For similar discussions and information on reflectors used by the United States, see following abstract.

5182 Paper in Abstract 5180. "Radar Reflectors Now Used in the Aids to Navigation System of the United States," C. R. Adams (U.S. Coast Guard, Civil Engineering Division), (13:-), Unclassified, AD 242 142.

This paper reviews the various types and characteristics of radar-enhancement devices used by the United States as aids to navigation; the results of measurements made on five test buoys with an X-band radar are also included. For similar information on reflectors used by other countries, see preceding abstract.

5183 Paper in Abstract 5180. "The Measuring of Reflecting Surfaces in Harbours," R. Manthey (Telefunken G.m.b.H.), (19:0), Unclassified, AD 242 140.

Echo-area measurements were made on a number of fixed and sea-surface targets in the Hamburg harbor with a harbor-surveillance radar. The purpose was to determine problems arising from limited resolution of the instrument and consequent obscuration of targets of interest in channels by strong echoes of neighboring fixed object. Language problems make the paper somewhat difficult to understand.

5184 Paper in Abstract 5180. "Development of an Instrument for Objective Measuring and Recording of the Reflection Properties of Radar Targets," W. H. Schoenfeld and H. Kaune (Hanover Technical College), (27:0), Unclassified, AD 242 130.

Description of an instrument developed for automatically recording the strength of radar echoes. The instrument is so designed as to be capable of use with many different radars. Signals are received from the radar receiver IF channel and a representation of signal strength on a logarithmic scale is fed to a paper-tape recorder as well as a CRT display. As with the preceding paper, language problems make the discussion somewhat difficult to follow.

5185 Paper in Abstract 5180. "Measuring Method for Radar Reflector," M. Morita (Maritime Safety Board, Japan), (9:0), Unclassified, AD 242 134.

Description of a few measurements of cross-section for various types of reflectors. Results are too fragmentary to be useful, and no novel techniques appear to have been employed. Again, there is a language problem.

5186 Paper in Abstract 5180. "Results of Some Measurements Made with a Measuring Instrument for Echo Intensity to Determine the Radar Reflection Range of Aids to Navigation," Mr. Haase (Federal Ministry for Transport, Germany), (21:2), Unclassified, AD 242 137.

COAST GUARD (CONT.)

5186 (Cont.)

An experimental survey was made of coastal targets using the echo-intensity measuring instrument described in the paper of Schoenfeld and Kaune (see above). The aim was to determine whether a meaningful radar range may be specified for such coastal targets as lighthouses, lightships, buoys, etc., analogous to the visual range normally specified in navigation aids. It was concluded that by specifying the radar range relative to some "standard" radar instrument, a useful parameter of the target can probably be achieved.

5187 Paper in Abstract 5180. "A Note on the Theoretical Maximum Range to Be Expected from a Radar Reflector," (Trinity House, England; Research and Development Section), (16:2), Unclassified, AD 242 128.

Description of a method for assessing the probable range to be expected from a radar reflector under various conditions. It is assumed that the reflector is oriented to give maximum response in the viewing direction; formulas are developed for a propagation constant under certain conditions of radar-antenna height, target height, range, and polarization. The resulting propagation constant is used to modify the normal radar equation; thus the maximum radar range for the reflector could be obtained, given the necessary radar constants and the radar cross-section of the reflector under consideration. A specimen calculation is presented in an appendix.

5188 Paper in Abstract 5180. "Range Comparison of Radar Reflectors for Wooden Spar Buoys," H. R. Smyth and J. A. Hehir (National Research Council of Canada), (5:0), Unclassified, AD 242 141.

Tests were carried out to compare the performance of three types of metallic radar reflectors for use on wooden spar buoys in a channel. The three types were a 28-inch stack of 4.25-inch tetrahedrons, a single 14-inch tetrahedron, and a single 18-inch tetrahedron. It was found that the single 14-inch reflector gave about 10% greater range than did the stack of small reflectors, and the 18-inch reflector gave 25% greater range.

5189 "Eighth International Lifeboat Conference, Bremen, Germany, 1959," (1959), (1 vol.:-), Unclassified, AD 228 258.

This volume contains eight papers, only one of which is pertinent to radar reflectivity. "Radar Reflectors for Lifeboats," by E. M. Lipsey, is an abbreviated and elementary treatment of the potential usefulness of Luneburg lenses in solving problems encountered in radar situations at sea. Another form of spherical dielectric lens with a much larger radial gradient of refractive index than a Luneburg lens is proposed to give omni-directional reflections and also to reflect circularly polarized waves.

COMBAT DEVELOPMENT AND TEST CENTER (VIETNAM)

5190 Test Report on CDTC-V Task 75D, "Evaluation of the Chaff Rocket for Outpost Communications," M. Cook and C. T. Ho, 27 Aug 63, (10:0), Unclassified, AD 424 669.

An operational evaluation was performed in Vietnam to determine if ground-launched chaff rockets can be employed as a signaling device reliable enough when used with a GCI radar to indicate that an outpost is being attacked. Field tests were conducted by firing fifty-three rockets from sites distant 12 to 53 nmi from

COMBAT DEVELOPMENT AND TEST CENTER (VIETNAM) (CONT.)

5190 (Cont.)

the GCI radars, and determining if the radar operators could observe the presence of the chaff clouds and pinpoint their location. Rockets containing three ounces of aluminum chaff were fired to a height of 2000 to 2400 ft. Under ideal conditions such as favorable weather and ranges greater than 37 nmi (to reduce ground clutter), the chaff rockets were detected by forewarned GCI operators. However, with unbriefed operators and inclement weather, less than 10% were observed. It was concluded that the chaff rocket was unsuitable as an outpost signaling device.

CONDUCTRON CORPORATION

5191 Report 0047-50-T, "Bistatic Diffraction by a Cone Sphere," C. M. McDowell, 13 Mar 64, (109:6), Unclassified, AD 444 926.

A theoretical estimate is obtained for the contribution of diffracted fields to the bistatic cross-section of a perfectly conducting cone-sphere. A geometric approach is used so the method can be extended to include the case of a ferrite-coated cone sphere. Since exponential damping occurs rapidly for higher modes, only fields in the lowest mode are considered. Limitations of the approach and requirements for more detailed studies are cited.

CONSIGLIO NAZIONALE DELLE RICERCHE (UNIVERSITY OF FLORENCE, ITALY)

5192 Technical Note 3 (AFCRC-TN-60-150), "Volume Density of Radio Echoes From Meteor Trails," N. Carrara, P. F. Checcacci, A. Consortini, and L. Ronchi, AF 61(052)-227, Oct 59, (23:12), Unclassified, AD 234 545.

Theoretical expressions are given for calculating the volume density of radio echoes from meteor trails. These expressions take into account not only trail orientation, but also the meteor evaporation process, and characteristics of the transmitter-receiver system. Both forward- and backscattering are considered.

5193 Technical Note 5 (AFCRL-116), "Observations on the Quadrantid Shower," P. F. Checcacci and M. Schaffner, AF 61(052)-227, Mar 60, (18:0), Unclassified, AD 259 289.

Presents data obtained from observing the January 1960 Quadrantid meteor shower with a 40-Mc radar, comprising distance, duration, relative intensity, and rate of meteor echoes.

5194 Technical Note 1, "Determination of the Direction Corresponding to the Maximum Rate of Radar Echoes from Meteor Trails," N. Carrara, P. F. Checcacci, L. Ronchi, and A. M. Scheggi, AF 61(052)-477, Dec 60, (23:8), Unclassified, AD 263 876.

A procedure previously developed (see Abstract 5192) is applied to determine the altitude that corresponds, in a given direction, to the maximum density of echoes from meteor trails which can be detected by a given radar. The azimuth corresponding to the maximum rate of radio echoes is also found. The assumption is made that the radiant distribution is uniform.

5195 Technical Note 2 (AFCRL-952), "The Volume Density of Radar Echoes from Meteor Trails, in the Case of Uniform Distribution of the Heliocentric Radiants," N. Carrara, P. F. Checcacci, L. Ronchi, and G. Tassinario, AF 61(052)-477, Jul 61, (34:5), Unclassified, AD 274 468.

CONSIGLIO NAZIONALE DELLE RICERCHE (UNIVERSITY OF FLORENCE, ITALY) (CONT.)

5195 (Cont.)

Derivation of general formulas expressing the volume density of reflection points of meteor trails, as well as the volume density of radar return. All derivations are in terms of the heliocentric velocity distribution. An example treats the case of a uniform distribution of heliocentric radiants.

5196 Technical Note 1 (AFCRL-62-546), "Radar-Echo Rate from Shower Meteors. Part 1: Theoretical Investigation," N. Carrara, P. F. Checcacci, A. Consortini, and L. Ronchi, AF 61(052)-592, 10 Apr 60, (18:3), Unclassified, AD 284 504.

This document derives formulas for evaluating the number of shower meteor echoes observed by radar as a function of time and radar antenna bearing.

5197 Technical Note 2 (AFCRL-63-42), "On the Possibility of Discerning Sporadic Meteor Echoes and Shower-Meteor Echoes by Using a Wide-Beam Radar Set," N. Carrara, P. F. Checcacci, A. Consortini, and L. Ronchi, AF 61(052)-592, Sep 62, (16:12), Unclassified, AD 430 638.

This report discusses the possibility of discerning echoes of sporadic and shower meteors by using a wide-beam radar set. The discussion is based on experimental data collected during the August 1960 Perseid shower.

5198 Technical Note 5 (AFCRL-63-733), "Radar-Echo Rate from Shower Meteors. Part II: Range Distribution," A. Consortini and M. E. de Langer, AF 61(052)-592, Jul 63, (15:13), Unclassified, AD 421 767.

Theoretical calculations for range distributions of meteor echoes due to the Perseid shower. The results assume that the number of observed radar echoes per unit time depends on the meteor flow, the process of trail formation, the nature of the scattering process, and the characteristics of the radar. The effect on range distributions of varying these parameters is discussed. A rough comparison is also performed to determine the theoretical range distribution which best fits the experimental data.

5199 [Final] Technical Report (AFCRL-63-787), "Research on Meteor Trail Echoes," N. Carrara, P. F. Checcacci, A. Consortini, et al., AF 61(052)-592, Sep 63, (26:22), Unclassified, AD 423 410.

Reviews the status of meteor research performed at this activity. The report describes the 40-Mc radar used for observations and samples of experimental data showing range distribution of echoes from the August 1962 Perseid shower. Several theoretical factors, such as a definition of the volume density of radar-echo sources, are briefly discussed.

COOK ELECTRIC COMPANY

5200 Interim Progress Report PR-123-3, "Radar Propagation Studies," DAI 49-186-502 ORD(P)-306, 18 Jun 57, (22:0), Unclassified, AD 137 739.

Tests were made on a system of level selectors and range gates arranged to operate on the received signal and, by means of counters, statistically determine the rf attenuation of ground-reflected airborne radar energy. Flights were made in Ohio over St. Mary's Lake and over farmland near Dayton. A definite correlation was obtained between counts and type of terrain, but accuracy may be low.

COOPER DEVELOPMENT CORPORATION

5201 Final Report (Oct 1955-Dec 1956), "Window Aerological Sounding Projectile," A. W. Goodrich, Nonr-1838(00), 25 Apr 58, (24:-), Unclassified, AD 211 020.

A modified version of the Loki Rocket known as WASP (Window Aerological Sounding Projectile) was developed for carrying aloft chaff packages to provide radar-reflective clouds for tracking wind velocities up to 100,000 ft altitude. The chaff packages were developed by Standard Rolling Mills and comprised aluminum dipoles 0.016 inch wide and 0.00045 inch thick, cut for use with 3-cm radar. The report contains only a few comments on the performance of the chaff packages.

CORNELL UNIVERSITY, CORNELL AERONAUTICAL LABORATORY, INC.

5202 Research Information Series Report AP/RIS-1, "Scattering Coefficients for the Backscattering of Electromagnetic Waves from Perfectly Conducting Spheres," M. E. Bechtel, Dec 62, (62:4), Unclassified, AD 297 126.

Values of the complex scattering coefficient for a perfectly conducting sphere are graphed and tabulated as a function of the wave-number-radius product ka as it varies in increments of 0.02 from 0 to 50. The scattering coefficient is given in terms of its real and imaginary parts and also in gain-phase-angle rotation. Normalized radar cross-sections of the sphere are also tabulated, with an accuracy of six significant figures. The theory employed for the calculations is outlined and its limitations discussed. The incident wave was assumed to be linearly polarized, monochromatic, and plane.

5203 Research Information Series Report AP/RIS-2, "Polarization-Dependence in the Performance of a Ground Plane Cross Section Range," R. J. Wohlers, Dec 62, (7:-), Unclassified, AD 296 775.

Discussion of problems arising when a ground-plane range previously used for antenna-pattern measurements is proposed for use in measuring radar cross-section. Contains a brief theoretical discussion of the effect on the far-field pattern of ground reflections for horizontal and vertical polarization, and the results of a brief experimental simulation of a 200-Mc ground-plane range using K_a-band equipment.

5204 Final Report C-1074-P-1 (AFCRC-TR-60-132), "Tropospheric Scattering Propagation Investigation," W. K. Klemperer, AF 19(604)-1835, 19 Feb 60, (59:27), Unclassified, AD 237 421.

A 395-mile scatter link operating at 915 Mc was used to obtain probability-amplitude distributions and power spectra for the received signal over long periods of time (e.g., 2300 hours). Characteristics of the received signal were compared with such meteorological phenomena as wind shear in the scatter volume. Significant conclusions were: (1) the fading range of the received signal is generally not Rayleigh-distributed for as long as 15 minutes; (2) Rayleigh distributions were observed for sampling intervals of the order of 100 seconds; (3) Gaussian power spectra may occur for very short periods of time, but seldom persist long enough to permit statistically valid observations; (4) fading range correlates well with wind shear in the scatter volume; and (5) aircraft traversing the scatter volume are detectable by Doppler "beats," increase in mean signal strength, and a greater fading range. Plans for lunar and auroral echo studies to be conducted on another program are described, along with a theoretical definition of the method for computing a Doppler map of the moon with the aid of an earth-based transmitter.

CORNELL UNIVERSITY, CORNELL AERONAUTICAL LABORATORY, INC. (CONT.)

5205 Summary Scientific Report CM-1393-P-4 (AFCRL-TN-60-1183), "Investigation of Lunar and Auroral Radio Echoes," H. A. von Biel, AF 19(604)-6116, 15 Oct 60, Unclassified, AD 251 632.

(BD-1820) This report summarizes work carried out and results obtained in an experimental investigation of lunar and auroral echoes at 915 Mc. Preliminary results indicate that about 90% of the total power contained in lunar echoes is reflected from an area on the moon not larger than 3% of the visible lunar surface. The echo exhibits Rayleigh-like fading when averaged over a one-minute time interval. There is evidence that the entire lunar surface contributes toward the total echo power. No auroral echo data were collected during this performance period.

5206 Final Report CM-1393-P-7 (AFCRL-62-78), "An Experimental Investigation of Lunar and Auroral Scattered Signals. Part I. Lunar Echoes," H. A. von Biel, AF 19(604)-6116, 15 Jan 62, (74:3), Unclassified, AD 273 686.

Summary of an experimental investigation of lunar echoes at 915 Mc, and results obtained. Transmission loss between isotropic radiators over the earth-moon-earth path was established as 280 dB at 915 Mc. This result, when compared with transmission losses reported by others at frequencies from 200 Mc to 3000 Mc, implies that the moon's cross-section is frequency dependent, decreasing with increasing frequency at about 6 dB per octave. At 915 Mc, the lunar cross-section was found to be 4.2×10^{10} m^2.

After detection, the lunar echo at 915 Mc exhibits Rayleigh-like fading with an average 10-to-90% fading range of about 14 dB. There is evidence, however, that the lunar echo is not entirely randomly phased but contains a steady-signal component in the ratio of 1.5 to 1 with the (rms) scattered-signal components, i.e., 47% scattered power and 53% specular reflected power. At 915 Mc the lunar echo exhibited polarization changes between moon-rise and moon-set as large as 50°; variations in excess of 30° in signal polarization have been measured from day to day. Useful appendices are given on the following: equipment used; a beam-type parametric amplifier; calibration of the large antenna with noise sources; computation of the lunar Doppler map.

5207 Final Report CM-1407-P-1 (AFCRL-62-443), "Investigation of Radio Aurora. Project Aurora II," W. A. Flood, AF 19(604)-6197, May 62, (20:16), Unclassified, AD 277 362.

Existing experimental evidence on auroral backscatter is shown to be consistent with the idea that the backscatter arises from turbulent fluctuations of electron density described by a Kolmogoroff spectrum rather than a Gaussian spectrum. Data would seem to indicate an inner scale of turbulence of 1 meter. Rice-type amplitude distributions occasionally observed at 49.7 Mc are taken to indicate the presence of ionized regions of good size in the aurora with electron densities in excess of $2 \times 10^7/cm^3$. The report opens with a brief review of auroral theory and experimental data.

5208 Report GM-1580-G-101, "Re-Examination of Minimum Range Criteria for Radar Cross Section Measurements," L. Hendrick and R. E. Kell, AF 04(647)-930, 3 Aug 62, (22:1), Unclassified, AD 445 412.

CORNELL UNIVERSITY, CORNELL AERONAUTICAL LABORATORY, INC. (CONT.)

5208 (Cont.)

This analytical investigation indicates that in many cases the presently accepted criterion of L^2/λ for antenna-target separation may be relaxed. The investigation shows that: (1) the criterion chosen should be intimately related to the nature of the cross-section data desired; (2) minimum range can usually be made less than L^2/λ and the allowable percentage reduction increases as target size increases; and (3) maintenance of an adequate beamwidth is important. Sample analytically developed curves are presented which show radar cross-sections vs. range, target size, and antenna beamwidth. A curve is included which relates minimum range to maximum target dimension and which may be used to make a rough estimate of allowable range.

Note: The work described in this report was presented in a symposium paper (see Abstract 5910).

5209 Report JA-1087-T-1, "Doppler Radar Observations of Weather and Aircraft Spectra," D. A. Barczys, J. Q. Brantley, T. McLean, and D. R. Rhodes, Jun 57, (43:13), Unclassified, AD 202 486.

Doppler spectra were obtained from precipitation in a variety of circumstances, as well as from aircraft. An attempt is made to explain the spectral shapes observed by considering first the simple case of a single falling sphere, and next that of rain falling through tropical-wind configurations. A comparison of theoretical and observed frequency spectra of a light drizzle enables the relative broadness of the observed spectrum to be attributed to atmospheric turbulence, reflections from drops in the side lobes, antenna beamwidth, or a difference between actual and assumed drop-size distributions. Briefly treated are frequency spectra from several cross-sections of a thunderstorm with light and heavy rain, spectra from snow in gusty and smooth air, and a spectrum from light rain with sharp wind variations aloft. Spectra are presented from several aircraft and a helicopter at various aspects. It is suggested that rough speed estimates may be inferred from spectrum widths; however, no conclusive data were obtained. An appendix suggests that Doppler techniques might be used in locating and identifying tornadoes. Brief mention is also made of the principles behind and the modus operandi of a Doppler radar.

5210 Final Report RA-1319-P-3 (AFCRL-243), "A Study of Spread F," W. K. Klemperer, AF 19(604)-5460, Oct 60, (19:10), Unclassified, AD 255 188.

A study of spread F, a night-time echoing condition giving diffuse radar returns over a considerable range interval. A scheme is devised for determining the spread in arrival angle of radio waves under spread-F conditions; a few measurements were made. Information about the nature of reflection and scattering from the ionosphere during spread F was also obtained by analysis of probability-density distributions and power spectra. Simultaneous data were taken, in conjunction with a radio-astronomy program, to relate the occurrence of spread F to radio-star scintillation; a marked positive correlation between the two events was observed. Equipment for determining ionospheric drift velocities during spread F was installed and theoretical work begun on the subject of scattering near the level of reflection in the ionosphere. Angle-of-arrival measurements were taken at 3.3 Mc using pulsed transmissions and lobe sweep rates of 3 and 10 cps. Observations at 2.4 Mc showed fading rates of less than 1 cps and power spectra widths of less than 1 cps.

CORNELL UNIVERSITY, CORNELL AERONAUTICAL LABORATORY, INC. (CONT.)

5211 Final Report RA-1505-P-1 (AFCRL-62-208), "Project FLAYER. A Study of Spread-F Echoes from the Ionosphere," W. K. Klemperer, AF 19(604)-7979, 30 Nov 61, (95:-), Unclassified, AD 270 846.

(RC-3458) To investigate the mechanism responsible for spread-F, an experiment was designed to determine the angular spectrum of radio waves reflected from the ionosphere under spread-F conditions. A lobe-swept interferometer was operated at spacings from 5.5λ to 12.5λ. Fringe visibility data obtained with the interferometer indicate that the type of spread-F observed at high geomagnetic latitudes has a narrow angular spectrum. This behavior is attributed to the guiding action of field-aligned irregularities of ionization within the F-layer.

5212 Scientific Report RM-1182-P-1 (AFCRC-TN-58-653), "Interim Report on Project Aurora," W. A. Flood, AF 19(604)-2454, 14 Oct 58, (26:12), Unclassified, AD 209 501.

Results of simultaneous dual-frequency radar observations of aurora during the spring of 1958. The major point of interest to emerge from the observations is the fact that echoes at 226 Mc do not always appear at the same range as echoes at 50 Mc. The consequences of these observations are examined in relation to presently available theories of auroral radar echoes.

5213 Report UB-1088-P-100, "Project RUBY. Errors in the Measurement of Radar Echoing Patterns: A New Minimum Range Criterion," W. P. Melling, DA 30-115 ORD-739, 9 Jan 57, (-:4), Unclassified.

(BD-2589) A formulation is provided of the target range required for satisfactory measurement of echo area in a radar test site. When a conventional antenna is used against a target larger than about 10λ, the necessary range is usually given by PD^2/λ, where D is the maximum projected target model dimension seen by the antenna, λ the test wavelength, and P a constant (of the order of 3) which effectively defines the quality of measurement. This formulation may fail when the target is near the end-on position, when the test range should not be made less than 5P times the length of the target. The validity of the criterion is not yet established for cases where it indicates that the target be placed in the near zone of the antenna.

5214 Report UB-1088-P-103, "Error Analysis of Ruby Radar Cross Section Measurement System," R. J. Wohlers, DA 30-115 ORD-739, 31 May 58, Unclassified.

(BD-2592) Project RUBY is a radar cross-section study program encompassing both theoretical and experimental investigations. This report analyzes the errors common to CW bridge equipment used for measuring cross-section and shows what factors must be controlled to minimize errors. The precision possible with RUBY's X-band, CW cross-section measuring radar is also discussed.

5215 Report UB-1088-P-104, "An Analysis of Radar Cross Section Measurement Techniques," W. P. Melling, DA 30-115 ORD-739, 18 Sep 59, (29:4), Unclassified, AD 289 320.

A useful discussion of practical and theoretical problems encountered in measuring radar cross-section by modeling techniques, particularly aimed at comparing the relative merits of CW and pulse systems. It is concluded that a CW radar is best suited for measurements with small targets. Excellent

CORNELL UNIVERSITY, CORNELL AERONAUTICAL LABORATORY, INC. (CONT.)

5215 (Cont.)

sensitivity is possible when maximum target dimension is less than one or two wavelengths. The CW radar is unsatisfactory when target dimension exceeds about 5λ to 10λ. A pulsed system can provide sensitive measurement of cross-section for targets larger than about 5λ to 10λ. Sensitivity is limited chiefly by return from supports, and is probably maximum with the highest feasible radar frequency. At K_a-band, cross-section measurement with sensitivity better than 1 λ^2 appears possible if target dimension is on the order of several tens of wavelengths. There is brief mention of interfering return from insects.

Ed: This statement is inconsistent with a conclusion of Kouyoumjian, compare Abstract 2458.

5216 Semiannual Report [UB-1309], "High Power Project," L. H. Groth, DA 30-069 ORD-2554, ARPA Order 53-59, Jul 61, Unclassified.

(BD-1729) Topics include: electron backscatter; electromagnetic backscatter; "incoherent" scatter mechanism; and scatter from the tropospheric and ionospheric regions.

5217 Semiannual Report UB-1309-P-106, "High Power Project," L. J. Anderson and L. H. Groth, DA 30-069 ORD-2554, ARPA Order 53-59, Dec 61, Unclassified.

(BD-2772) Topics include the experimental study of secondary noise levels which may be power dependent. This includes energy backscattered incoherently from the earth's ionosphere as well as energy returned coherently by the aurora, magnetic-field-aligned streamers, and other discontinuities at ICBM ranges. Estimates of the detectability of major clutter sources to be expected at ICBM ranges have also been made.

5218 Semiannual Report UB-1309-P-109, "High Power Program. High Power Project--Project Delilah," L. J. Anderson and L. H. Groth, DA 30-069 ORD-2554, ARPA Order 53-59, Jun 63, Unclassified.

(BD-5099) During the first half of 1963, effort under the HIGH POWER project was concerned with two general areas. The first of these was a study of the radar clutter caused by incoherent ionospheric backscatter. It was concluded that the maximum clutter detected to date in the pulse volume of the radar is 10^{-17} watts at 30-MW illumination intensity--in close agreement with the expected return from measured electron-density profiles. The second area of effort was that of improving the versatility of the Newstead radar. The antenna was converted to a Cassegrain configuration, thereby increasing the gain to 52.7 dB, and a programmed tracker was developed for pointing the antenna to follow any prescribed trajectory across the sky.

5219 Semiannual Report UB-1309-P-110, "High Power Program. High Power Project--Project Delilah," L. J. Anderson and L. H. Groth, DA 30-069 ORD-2554, ARPA Order 53-59, 31 Dec 63, (33:6), Unclassified, AD 427 765.

Describes radar observations of satellites and aurora by an S-band radar having gigawatt peak power and located at Cornell University. Maximum radar cross-section was measured for spherical targets, exemplified by VANGUARD II and ECHO I, and for such cylindrical targets as AGENA second-stage boosters. Pulse shape was also investigated from ECHO I returns. Data presented are: (1) typical satellite echoes; (2) pulse-shape photographs for ECHO I and calibration pulses; and

CORNELL UNIVERSITY, CORNELL AERONAUTICAL LABORATORY, INC. (CONT.)

5219 (Cont.)

(3) observed peak radar returns for five satellites at ranges from about 600 to 3000 km. In regard to the latter, it is concluded that the cross-sections of the various satellites investigated have not been appreciably augmented or reduced by their motion through the ionized media. Data indicated that pulse-to-pulse fluctuations cannot be attributed to the effects of the propagation medium. The radar was also used to observe auroral clutter and measure elevation angle vs. range for auroral return. Data points fell within a degree of a specular-return condition. The radar beam was normal to the magnetic field lines at auroral heights.

5220 Final Report UB-1326-P-1, "Atmospheric Reconnaissance Using Extremely High Frequencies," L. Wijnberg, AF 33(616)-6350, May 60, (47:31), Unclassified, AD 241 746.

The propagation of radio waves of millimeter wavelength was studied, with emphasis on the theory of radiometry observations. The measurement of liquid water in clouds, transmission and scattering in a partially ionized atmosphere, and scattering in a clear turbulent atmosphere are studied in detail. The scattering cross-section of radio waves by free electrons is derived, with proper consideration of the ions present; this calculation reveals a potentially useful wavelength dependence. A research program is suggested to establish criteria for determining the utility of radar probes for detecting severe clear-air turbulence.

5221 Final Report UB-1327-P-1, "Meteorological Radar Echo Study," A. J. Chimera, AF 33(616)-6352, Sep 60, (62:14), Unclassified, AD 246 096.

A study of the information contained in radar echoes, with emphasis on Doppler radar techniques. The measurement of rainfall rates and turbulence, techniques for signal enhancement, and the interpretation of weather-echo fluctuations are considered. A general formula is developed for the shape of the Doppler spectrum of the radar signal returned by a meteorological target, and specific solutions are derived for cloud, snow, and rain. It is suggested that information about turbulence, the component of mean wind in the direction of the radar beam, and rainfall rate with a vertically directed beam may be obtained from the Doppler spectrum, which gives the probability density of velocity within the illuminated volume. Limited experimental verification includes photographs of VICI (velocity-indicating coherent integrator) displays of velocity vs. range, and wind profiles from VICI and rawinsonde data; results indicate that the Doppler technique will yield fruitful results in measuring both steady-state and turbulent wind velocities.

5222 Report UB-1473-P-2 (Final Report, Part II), "Radar Cross Section Minimization Study--Project Zephyr," W. P. Melling and J. J. Clark, DA 30-069 ORD-3113, 20 Jul 61, (82:21), Unclassified, AD 419 930.

This program was aimed at determining the limits to which the radar cross-section of missile nosecones can be reduced by shaping techniques. Part I of the Final Report is Secret and includes the experimental results of the project. This volume, Part II, contains seven unclassified appendices, each of which comprises a more-or-less independent study on some aspect of scattering theory. They are as follows:

CORNELL UNIVERSITY, CORNELL AERONAUTICAL LABORATORY, INC. (CONT.)

5222 (Cont.)

"Cylindrical Current Theory," (15:4).

A formula is derived for the backscatter cross-section of perfectly conducting pointed-nose bodies of revolution, using cylindrical current theory. Some approximate closed-form results are then obtained from it for the finite cone and for the sphere-capped cone. Comparison with direct numerical integration of the formula and with experimental values gives good agreement.

"Geometrical Theory of Diffraction," (12:7).

Sets out briefly the main lines of Keller's asymptotic solution for backscattering of a plane wave from a perfectly conducting cone-sphere (Abstract 7483J), and outlines that contribution to the return arising from the surface-diffracted rays.

"Creeping Waves and Conical Tip Scattering for the Sphere-Capped Cone," (4:4).

Work of the previous appendix is extended, using creeping-wave theory, to include incidence angles greater than the semi-vertex angle of the cone. A physical-optics approximation is given for tip scattering, and the backscatter cross-section of a sphere-capped cone is found, assuming that the cross-section can be represented as a composition of creeping waves and conical tip scattering alone.

"A Series Method for Solution of Boundary Value Problems in Wave Theory. Part I-Scalar Case," (13:4).

A method is presented for obtaining infinite series solutions to boundary-value problems in wave theory. The method is not limited to regions whose bounding surfaces are coordinate surfaces of elementary coordinate systems, and may be employed to obtain the electromagnetic field scattered from a perfect conductor, or scalar acoustic waves scattered from hard or soft bodies.

"A Series Method for Solution of Boundary Value Problems in Wave Theory. Part II-Vector Case," (20:2).

The problem considered is the scattering of electromagnetic radiation by a smooth body embedded in a homogeneous isotropic medium.

"A Procedure for Converting Mean Value of 10 Log_{10} (σ/λ^2) to Mean Value of σ/λ^2," (3:0).

"The Physical Optics Description of the Radar Cross Section of a Sphere-Capped Cone," (6:0).

5223 "Electronic Audio Recognition Study," A. E. Murray, DA 36-039 SC-90770, Unclassified.

Report	Report	Date	Pages:Refs.	AD No.
QPR 1	UB-1721-X-1	30 Sep 62	12:-	299 132
QPR 2	UB-1721-X-2	31 Dec 62	18:-	402 820
QPR 3	UB-1721-X-3	31 Mar 63	14:-	414 837
Final	UB-1721-X-4	31 Jul 63	61:0	

These reports document a study aimed at determining the feasibility of an electronic device capable of detecting and classifying such moving targets as personnel and vehicles in natural clutter by processing the audio output of a Doppler battlefield radar. The Final Report adequately summarizes the entire

CORNELL UNIVERSITY, CORNELL AERONAUTICAL LABORATORY, INC. (CONT.)

5223 (Cont.)

program, including most of the material in the quarterlies. Sample signals recorded in the field were subjected to a variety of measurements and analyses. A relatively simple method for detecting short bursts of target signals in clutter was devised. The method is based on comparison of two different measures of short-time running average frequency which can be measured and compared in state-of-the-art analog circuits and requires about a half-second of target signal.

CORNELL UNIVERSITY, CENTER FOR RADIOPHYSICS AND SPACE RESEARCH

5224 Research Report RS 1 (Scientific Report 1; AFCRC-TN-60-124), "Comments on the Problem of Incoherent Scattering," T. Laaspere, AF 19(604)-6158, ARPA Order 106-60, 15 Dec 59, (53:8), Unclassified, AD 234 842.

A continuing discussion of Gordon's prediction (see Abstract 5235) that detectable scattering of radio waves in the ionosphere will occur at frequencies so high that the associated characteristic scale ($\lambda/2$ for backscatter) is smaller than the mean free path. The author defines and discusses "thermal scattering," a term synonomous with the "incoherent scattering" used by Gordon. Thermal scattering due to Doppler shift is discussed as well as scattering due to irregularities in electron density, magnetic field effects on the backscatter spectrum, and scattering by moving free electrons. Appendices include detailed theoretical treatments of: (1) the backscatter spectrum assuming incoherent scattering by individual electrons; (2) the problem of addition of powers in radar backscatter; (3) scattering from a moving string of dipoles; (4) density fluctuation in an ideal gas; and (5) Born's scattering theory.

5225 Research Report RS 8 (Arecibo Radio Observatory Scientific Report 3; AFCRC-TN-60-397), "Scattering of Radio Waves by Electrons above the Ionosphere," E. E. Salpeter, AF 19(604)-6158, ARPA Order 106-60, 18 Apr 60, (5:4), Unclassified, AD 238 338.

Considers the theoretical aspects of wave scattering by electron gases above the ionosphere for the case where the parameter $\underline{a}$, defined as $(\lambda D/4)\sin(\theta/2)$, is approximately unity. D is the electron Debye length and θ is the scattering angle. The effect of the earth's magnetic field is omitted and the frequency is assumed to be very large compared with the plasma frequency of the electron gas. Electron collisions are ignored. A frequency spectrum of the scattered energy is postulated as a function of θ and briefly discussed.

5226 Research Report RS 10 (Scientific Report 6; AFCRL-TN-60-1161), "Range, Declination, and Doppler-Shift Calculations for an Interplanetary Radar," L. M. LaLonde, AF 19(604)-6158, ARPA Order 106-60, 30 Jun 60, (100:2), Unclassified, AD 250 477.

Describes plans to receive radar echoes from planets, using the Arecibo Radio Observatory, then under construction. Calculations show that Venus, Mars, Mercury, and Jupiter are likely targets for this facility. Since the planets have a pre-determined motion with respect to the radar on the earth's surface, Doppler shifts must be predicted in order to tune a narrow-band receiver to the frequency of the reflected echo. An approximate equation is given for the relative velocity of a planet. The report comprises 13 pages of text, and 87 graphs showing radial velocity, range, and declination of all planets except Pluto for the years 1960-1967.

CORNELL UNIVERSITY, CENTER FOR RADIOPHYSICS AND SPACE RESEARCH (CONT.)

5227 Research Report RS 15 (Scientific Report 4; AFCRL-TN-60-790), "An Analysis of the Effect of an Imposed Magnetic Field on the Spectrum of Incoherent Scattering," T. Laaspere, AF 19(604)-6158, ARPA Order 106-60, 15 Jul 60, (75:19), Unclassified, AD 244 557.

Continuing discussion of incoherent backscattering of radio waves by electrons (see Abstract 5224) emphasizing magnetic field effects on the scattered spectrum. This report includes: (1) the general problem of the type of scattering predicted by Gordon; (2) a derivation of the expression used to define scattering by moving electrons; (3) the effect of an external magnetic field on the forced vibration of electrons; (4) a derivation of the line spectrum of radar backscatter with a radar beam directed perpendicular to the magnetic field; (5) the line spectrum characteristics at any angle to the magnetic field for both back and forward scatter; and (6) the application of (1)-(5) to ionospheric scattering research. Although the work is theoretical, practical parameters are used to calculate sample backscatter spectra. Analysis showed that the spectrum of the received scattered field of each electron will consist of lines with the separation equal to the electron gyromagnetic frequency. The resultant spectrum is a superposition of such line spectra. Basic assumptions were random spatial distribution of electrons and a Maxwellian velocity distribution.

5228 Research Report RS 29 (Theoretical Studies--Arecibo, Scientific Report 1; AFCRL-62-104), "Notes on the Characteristics of Radar Signals in Incoherent Scattering," T. Laaspere, AF 19(604)-8804, ARPA Order 106-61, 30 Sep 61, (31:20), Unclassified, AD 274 721.

Continuing treatment of incoherent backscattering of radio waves by electrons (see preceding abstract) discussing the accuracy with which electron temperature in the ionosphere can be determined by measuring the spectra of incoherent return. The analysis includes the characteristics of CW and pulsed returns in a bistatic experiment. An appendix uses the work of Salpeter ("Electron Density Fluctuations in a Plasma," Phys. Rev. 120, 1528-35 (1960)) to obtain ionospheric temperatures, neglecting the effects of pulsing and gating. Spectra are calculated for the 430-Mc Arecibo radar using various ionospheric reflection heights.

5229 Research Report RS 32 (Scientific Report 1; AFCRL-62-462), "Some Characteristics of Radar Angel Echoes," N. Vrana, AF 19(604)-6160, 30 Sep 62, (29:7), Unclassified, AD 277 903.

(BD-4034; RC-8236) Time-lapse motion-picture data was taken of the A-scope radar response to angels. Information recorded over a two-day period indicates that the echo characteristics may be segregated and are reasonably consistent within each of three distinct periods. Values of some characteristics, when averaged separately for each period, are different from corresponding characteristics of other periods. These data reveal some of the detailed manifestations of angel activity.

5230 Research Report RS 41 (Arecibo Ionospheric Observatory Summary Technical Report), "Research in Ionospheric Physics," W. E. Gordon, L. M. LaLonde, and T. E. Talpey, AF 49(638)-1156, ARPA Order 270-62, 30 Jun 62, Unclassified.

(BD-3223) Topics discussed are ionospheric studies and radar astronomy including lunar echoes, planetary echoes, and solar echoes.

CORNELL UNIVERSITY, CENTER FOR RADIOPHYSICS AND SPACE RESEARCH (CONT.)

5231 Research Report RS 44 (Arecibo Ionospheric Observatory Summary Technical Report 2), "Research in Ionospheric Physics," W. E. Gordon, L. M. LaLonde, T. E. Talpey, et al., AF 49(638)-1156, ARPA Order 270-62, 31 Dec 62, (30:6), Unclassified, AD 297 354.

Report of the construction status of the Arecibo facilities, as of 31 December 1962. Also described is research performed at Cornell on plasma physics and on modeling the ionosphere for density and Faraday rotation measurements, as well as qualitative characteristics of lunar echoes received at the Danby Observatory from Arecibo transmissions.

5232 Research Report 137 (Scientific Report 2; AFCRL-63-434), "Characteristics of Trackable Radar Angels," T. H. Roelofs, AF 19(604)-6160, 16 Jan 63, (52:12), Unclassified, AD 408 361.

A study of clear-air radar angels tracked on a 5.5-cm FPS-16 radar at Wallops Island, Virginia, at different times of the year under a variety of weather conditions. Comparison of the motions of wind echoes and angels reveals that the angels are undoubtedly windborne; hence, the possibility of birds, insects, or any flying thing as an explanation for these angels is eliminated. Angel cross-sections were found to have a very strong and consistent dependence upon elevation angle; they appear to be 30 to 100 times larger when directly overhead than when they are at a 60° elevation angle. It is suggested that the short-lived angels may have been produced by horizontal refractivity stratifications in the atmosphere, while the more persistent ones may have been caused by the distortion of a horizontal refractive-index stratification by a vertically moving air parcel such as a thermal. Some angels are attributed to the intense turbulence near the cap of a thermal. Various graphs are included; e.g., mean angel cross-sections vs. elevation angle.

CORNELL UNIVERSITY, SCHOOL OF ELECTRICAL ENGINEERING

5233 Research Report EE 360 (Technical Report 44), "VHF Radar Echoes Associated With Atmospheric Phenomena," G. C. Rumi, DA 36-039 SC-74903, 30 Jan [1958], (18:34), Unclassified, AD 158 857.

Discusses radar observations at 27.85 Mc performed during 1955 at Ithaca, N. Y. These observations give information about lightning, meteors, and aurora, and about the possible existence of "upward discharges" from the top of the troposphere to the bottom of the ionosphere. Photographs show amplitude-vs.-time plots of echoes that the author attempts to associate with upward discharges. Echo properties discussed include rise and delay speeds, duration, flatness, ranges of appearance, and repetition rate.

Note: This document is a reprint of a journal article (Abstract 7677J).

5234 Research Report EE 373 (Progress Report 2), "Studies on Propagation in the Ionosphere," H. G. Booker, B. Nichols, D. Farley, et al., DA 36-039 SC-74903, 31 Mar 58, (23:4), Unclassified, AD 161 788.

The major portion of the report is devoted to the explanation of low-frequency fading components of received signals observed during the course of a "quiet" day. Situations treated theoretically were wave interference due to (1) two or more hops from a single layer, and (2) single-hop F beating with single-hop E, assuming the ground ray to be negligible. Fading frequencies are obtained, using optical-path techniques, for specific situations of distance, frequency, E- and F-layer vertical heights and rates of change, etc. Also included are brief

5234 (Cont.)

discussions of: (1) phase scintillations of artificial satellite signals; (2) mode theory of spread F; (3) angle-of-arrival measurements; and (4) ionosphere-sounding equipment.

5235 Research Report EE 376 (Engineering Report 1), "Incoherent Scattering of Radio Waves by Free Electrons with Applications to Space Exploration by Radar," W. E. Gordon, AF 33(616)-5547, 31 (sic) Jun 58, (18:6), Unclassified, AD 202 314.

Describes techniques whereby a powerful radar can detect incoherent backscatter from free electrons in and above the ionosphere. It is stated that measures of electron density and temperature vs. height and auroral ionization can be obtained; also, transient streams of charged particles and ring currents can be detected. The report is divided into three areas: scattering by free electrons, applications of incoherent scattering to the investigation of the upper atmosphere and surrounding space, and capabilities of radar for additional exploration of space. Scattering coefficients are derived for a single free electron and for a free electron in an ionized medium. The Doppler shift obtained during scattering is related to the collision frequency of the electrons as well as to electron temperature, with both incoherent and coherent scattering being considered. (See also Abstract 5224.)

Note: For an article having the same title, see Abstract 8154J.

5236 Research Report EE 389 (Technical Report 49), "Studies on Propagation in the Ionosphere. Interpretation of Some Backscatter Echoes in Terms of Field-Aligned Irregularities in the F Region," P. F. Weaver, Jr., DA 36-039 SC-78258, 15 Dec 58, (86:24), Unclassified, AD 229 659.

Description of a study of long-range radar echoes at 14 Mc which seem to be explainable in terms of direct backscatter from field-aligned irregularities in the F-region. Echoes were regularly observable during the evening hours with a high-power pulsed transmitter and a rhombic antenna beamed northward. Direction-finding equipment was used to measure azimuth and vertical angles of arrival. The apparent points of reflection were in the F-region, and ionospheric sounder data established a correlation between the occurrence of spread F and the fast-fade echoes. Approximately half the report describes the transmitting and receiving antenna system, and methods of data processing and analysis. The fast-fading backscatter echo was observed to start abruptly at ranges of about 1200 km and spread out to 2000 km. Fading rates were usually above 10 cps. Described are the fading rates, shape of echo (amplitude vs. time), diurnal and seasonal changes, and locations of reflection points. The echo was definitely correlated with spread-F regions in the ionosphere by using ionosphere sounders located in the general region under the reflection point.

5237 Research Report EE 399 (Final Report), "Studies on Propagation in the Ionosphere," H. G. Booker, D. T. Farley, P. Weaver, and J. Renau, DA 36-039 SC-74903, 31 Dec 58, (70:23), Unclassified, AD 214 380.

Various investigations are described which deal with F-region ionospheric reflections, including an interpretation of some backscatter echoes in terms of field-aligned irregularities in the F-region. (This work is treated in more detail in Research Report EE 389--see preceding abstract.) Also included are discussions of two related problems: a theory of electrostatic fields in a horizontally stratified ionosphere subject to a constant, vertical magnetic field, and the

CORNELL UNIVERSITY, SCHOOL OF ELECTRICAL ENGINEERING (CONT.)

5237 (Cont.)

phenomenon of spread F in the ionosphere. Results from these two studies were also separately published as Research Reports EE 397 and 393, respectively. These reports are included in this document as appendices, and comprise 54 of its 70 pages.

5238 Research Report EE 425 (Quarterly Progress Report 2), "Studies on Propagation in the Ionosphere," D. Farley and J. Renau, DA 36-039 SC-78258, 15 May 59, (47:5), Unclassified, AD 225 627.

This report includes two studies: (1) "A Theory of Electrostatic Fields in the Ionosphere at the Equator," D. Farley (19:5); and (2) "A Study of Observed Spread F," J. Renau (24:0). No reflection or backscattering properties are included in the first study. The second is mostly devoted to a quantitative investigation of spread-F properties, with little emphasis on backscattering, primarily by the use of ionograms (frequency vs. layer height). Some correlation between backscatter amplitude and degree of ionization is mentioned.

5239 Research Report EE 428 (Radio Astronomy Technical Report 1), "Radar Echo from a Rough Rotating Planet," M. H. Cohen, Nonr-401(27), 1 Jun 59, (20:7), Unclassified, AD 225 628.

The reflection properties of a planet are assumed to be like those of a rough rotating sphere. Analysis of backscatter from such a body shows that a monochromatic incident wave has an echo whose spectrum I(f) takes the form

$$I(f) = I_m \left[1 - 2(f - f_m)^2/B^2\right] ,$$

where I_m is peak intensity, f is frequency, and B is width of the echo spectrum. The effect of orbital motion on B is deduced. It is shown how measurement of B over a range of orbital positions can fix rotation period and heliocentric ecliptic latitude and longitude of pole, except for one ambiguity. Earth-Mars and Earth-Venus situations are considered as well as the case of the non-rough planet.

5240 Research Report EE 440 (Engineering Report 6), "Observations of the Ionosphere at Frequencies above 100 Mc/s," W. E. Gordon, AF 33(616)-5547, 1 Sep 59 (13:52), Unclassified, AD 228 360.

Brief discussions of various topics such as amplitude and phase scintillation, auroral and meteor echoes, Faraday rotation, and upper-atmosphere absorption and refraction. Emphasis is on the character of the echoes. An extensive reference section is included.

CURTISS-WRIGHT CORPORATION

5241 Final Engineering Report 2F55-15F (NAVTRADEVCEN TR-115-1), "Radar Land Mass Simulator Experimental Model," M. Kamenetsky, N61339-115, 31 Oct 61, (130:-), Unclassified, AD 289 152 (DDC reference only).

(RC-4058) No abstract available. DDC descriptors: *Radar trainers, *Radar target position simulators, Mapping, Radar equipment, Radar scanning, Optical systems.

DEFENCE RESEARCH TELECOMMUNICATIONS ESTABLISHMENT (CANADA)

5242 Project Report 44-2-1, "Preliminary Data on Radar Returns from Aurora at 488 Mc/s," J. H. Chapman, B. C. Blevis, et al., Jan 58, (8:-), Unclassified, AD 153 331 (not available from DDC).

(DDC) Records from preliminary observations of radar echoes from aurora were obtained at Ottawa. From these, range-azimuth and range-elevation information was abstracted. The data was obtained during April 1957, using a frequency of 488 Mc/s. Echoes varied in range from about 380 km to 1200 km, and were received over a region of ± 35° in azimuth from magnetic north. Radar returns were obtained at elevation angles up to 13°; most returns, and in particular those at the larger elevation angles, originated fairly close to the 100 km level.

5243 "The Radar-Cross-Section of Right Circular Metal Cones," J. E. Keys and R. I. Primich, Unclassified.

Part	DRTE Report	Date	Pages:Refs.	AD No.
I	1010	May 59	173:5	217 921
II	1023	Aug 59	73:6	227 166

The first report concerns monostatic radar cross-sections of right-circular metal cones having nose angles of 8°, 15°, 19.2°, 24°, 30°, and 40°, measured as functions of aspect angle for horizontal and vertical polarizations. Included are a total of 168 radar-reflectivity patterns for these targets, with only two pages of text. A short-pulse radar and a CW balanced-bridge radar were used, both operating at 8.6 mm. The cones were machined from aluminum to a tolerance of ± 0.001 inch, with a surface finish of 12 microinches rms; cone angles were accurate to within one minute of arc.

In the second report, cones were measured having nose angles of 60°, 75°, 90°, 105°, and 120°; fourteen scaled sizes were measured for each angle. Base diameters ranged from $\lambda/3$ to 3λ. Seventy graphs show horizontal and vertical polarization measurements.

5244 Report 1052-U, "1960 Annual Report of the Defence Research Telecommunications Establishment," P. A. Field (Editor), Mar 61, (33:0), Unclassified--For Official Use Only, AD 254 245.

Describes DRTE activities in studying polar radio blackouts, ionospheric absorption and propagation, meteor-burst communications, radar cross-sections, and radar operation under interference conditions, including research in ionospheric topside sounding from satellites. The report is intended as a non-technical guide to DRTE activities and contains no detailed information.

5245 Report 1076, "Use of Focussed Antenna for Ionized Trail Measurements," R. I. Primich and F. H. Northover, Oct 61, Unclassified.

Note: This report was not obtained.

5246 Report 1085, "An 8.6 mm Short-Pulse Radar for Indoor Model Measurements," T. H. Legg, R. A. Hayami, and R. I. Primich, May 62, (20:13), Unclassified, AD 428 456.

Describes an 8.6 mm, short-pulse, quasi-monostatic indoor radar-reflectivity range. Separate transmitting and receiving antennas are employed, enabling study of forward and backscattering and of polarization effects; an isolation of about

DEFENCE RESEARCH TELECOMMUNICATIONS ESTABLISHMENT (CANADA) (CONT.)

5246 (Cont.)

130 dB between transmitter and receiver is achieved. Tunnel antennas keep the peaks in the radar cross-section of the support tower below 7×10^{-5} m^2. The peak transmitted power is about 30 kw. The 15-nsec transmitter pulse permits resolution of reflections from scatterers 10 ft or more apart. The cross-section of a target may be recorded automatically as a function of aspect, with an accuracy of $\pm$ 1 dB over a dynamic range of 50 dB.

5247 Report 1089, "A Target Simulator for a 35 Gc CW Doppler Radar," P. E. Robillard and W. E. Blore, Sep 62, (8:4), Unclassified, AD 297 123.

A simulator for use with a 35-Gc CW Doppler radar is described in moderate detail. This device produces a microwave signal to simulate both signal magnitude and Doppler frequency for the radar echo from a hypersonic projectile as a function of time. Included are block diagrams, a schematic diagram for the locking amplifier, and a discussion of operational principles. It is concluded that if a functional relationship can be found for the temporal variation of projectile velocity, the velocity-time function can be simulated with this system.

5248 Report 1100, "A Statistical Study of the Occurrence and Characteristics of Radar Auroral Echoes at 488 and 944 Mc/s," B. C. Blevis, Dec 62, (42:37), Unclassified, AD 299 567.

Description of radar backscatter observations of auroral ionization made with two similar systems operating at 488 Mc and 944 Mc. Observations took place in Ottawa between May 1959 and April 1961. Some significant results are: (1) the auroral echoes showed a double-peaked night-time maximum; (2) the probability of occurrence of echoes increases rapidly with increasing magnetic disturbances; (3) the average Doppler shift of the echoes exhibits a systematic diurnal variation; (4) received echo power varies as about the eighth or ninth power of wavelength; and (5) there is no distinct evidence of depolarization or rotation of the plane of polarization of the echoes. Observations of Doppler shift are discussed in terms of auroral ionization motion. Range and wavelength dependence of the echoes are used to infer certain properties of the scattering medium.

5249 Report 1105, "The Radar Cross-Section of Bodies of Revolution," W. E. Blore and G. M. Royer, Mar 63, (13:4), Unclassified, AD 406 112.

Radar cross-section measurements are presented for ogives, carrots, double-rounded cones, and double-backed cones, all at nose-on aspect. Plots show σ/λ^2 vs. body diameter in wavelengths. All experimental points are average results from at least two measurements with horizontal and vertical plarization. The measurement technique is not discussed.

DEFENSE DOCUMENTATION CENTER

5250 "Bibliography of Bibliographies," Compiled by K. M. Gibbs and E. H. Hall, Aug 62, (268:2000+), Unclassified, AD 281 900.

DDC abstract cards are reproduced for over 2000 unclassified bibliographies catalogued by DDC between 1953 and July 1962. Since all topics of research and development interest are included, only a few references are pertinent to radar reflectivity. Only unclassified and unlimited references appear here; a separate volume, AD 331 100, includes classified and limited unclassified citations. This

DEFENSE DOCUMENTATION CENTER (CONT.)

5250 (Cont.)

bibliography is a supplement to AD 74 436 and AD 147 723; it includes all references to AD reports listed therein, but not those to Air Technical Index (ATI) or Technical Information Pilot (TIP) entries. References are arranged alphabetically by source within subject categories.

5251 "A Bibliography of Bibliographies (Supplement)," Compiled by E. H. Hall, Aug 63, (106:682), Unclassified, AD 410 397.

DDC abstract cards are reproduced for 682 unlimited and unclassified bibliographies catalogued by DDC between July 1962 and July 1963. This volume is a supplement to AD 281 900 (previous abstract); classified and limited unclassified references appear as a separate volume, AD 338 580. Within subject areas corresponding to the 33 divisions in the DDC Distribution Guide, bibliographies are arranged alphabetically by source and title.

5252 "A Report Bibliography: Radar Cross Sections as Functions of Frequency (1956-1962)," Sep 62, (47:82), Unclassified, ARB 11 748.

Reproduces DDC abstract cards for 82 unclassified references on radar cross-section as a function of frequency, including those from 1956 to 1962. Cards are arranged in ascending order by AD number.

5253 "List of DDC Custom Abstract Searches," Jun 63, (109:570), Unclassified, AD 405 583.

An unclassified compilation of some 570 custom abstract searches conducted by DDC. Entries are listed by number (ARB or AD), title, and subject; bibliographic data includes only title, number of references, dates covered by the search, and search classification. Some are pertinent to radar reflectivity.

5254 "Radar Jamming and Deception (Bibliography, January 53-June 63)," R. B. Henery (Editor), (67:150+), Unclassified, AD 411 774.

DDC abstract cards are reproduced for more than 150 unclassified reports on radar-jamming studies. Entries are dated between 1953 and 1963 and are arranged in ascending order by AD number. Some are pertinent to reflectivity.

DEPARTMENT OF COMMERCE, JOINT PUBLICATIONS RESEARCH SERVICE

5255 JPRS: 16,728, "Radar Observations of Venus," V. A. Kotel'nikov, et al., 17 Dec 62, (7:7), Unclassified, AD 400 422.

Radar probing of Venus by the USSR in 1961 is treated. No details are given on instrumentation although the measurements are discussed thoroughly. The value obtained for the astronomical unit was 149,599,300 km with a mean-square error of 570 km. This is compared with other measurements obtained by earlier experiments.

Note: Translation of: Dokl. Akad. Nauk SSSR 145, No. 5, 1035-38 (Aug 62).

5256 JPRS: 18,986; OTS: 63-21724, "Soviet Reports on Meteor Observation by Radar," 30 Apr 63, (22:13), Unclassified, AD 408 862.

A translation of two articles from the Russian publication Sbornik rabot po mezhdunarodnomu geofizicheskomu godu (Collected works on the International Geophysical Year), No. 1, Kiev University Press (1961).

DEPARTMENT OF COMMERCE, JOINT PUBLICATIONS RESEARCH SERVICE (CONT.)

5256 (Cont.)

Radar Observation of Meteor Streams," V. G. Kruchinenko, R. J. Moysya, and J. V. Bayrachenko (17:8). Report on radar observation, at about 70 Mc, of meteor showers from 1 January 1958 to 1 December 1959, in which the general pattern of meteor activity and duration of echoes were measured.

"Apparatus for Experimental Investigation of the Scattering of Radio Waves by Meteor Trails," Ye. D. Podgorodetskiy (5:5). Briefly describes a four-frequency radar designed to measure the scattering of radio waves by meteor trails.
Note: The DDC-reproduced version of this report is nearly illegible.

DEWEY AND ALMY CHEMICAL COMPANY

5257 RLP 2205 (Final Report), "Development of Adhesive Compound and Rabal Balloons. Services, Facilities and Materials Leading to Design of a Radar Reflective Balloon," F. T. Mansur, NOas-56-790-c, 28 Feb 57, (24:-), Unclassified, AD 131 576.

Research and development efforts to determine an elastomeric cement capable of permanently adhering aluminum dipole reflectors to neoprene meteorological balloons. No reflectivity considerations are involved.

ELECTRO-JET CORPORATION

5258 "Satellite Plasma Sheath Anomalies," S. F. Singer, K. N. Sargent, R. T. Bettinger, and E. H. Walker, [1962], (129:56), Unclassified, AD 405 535 or AD 403 287.

An informal collection of seven papers relating to various aspects of the plasma sheaths and wakes characterizing hypervelocity missiles and their effects on problems of missile and satellite detection. The titles most pertinent to reflectivity are: "Plasma Sheath and Screening Around a Rapidly Moving Body" (38 pp); "Reflection of Radio Waves Incident to Boundary Surfaces with Application to the Theory of the Kraus Effect" (13 pp); and "The Generation of Electromagnetic Waves in the Wake of a Satellite" (4 pp), all by E. H. Walker.
Note: This document is reprinted by the Bureau of Ships from Electro-Jet's "Final Report under Contract NObsr-84714."

ELECTROMAGNETIC RESEARCH CORPORATION

5259 Report CRC-5198-2 (Scientific Report 1; AFCRC-TN-60-173), "A Review of Theories and Measurements of Radar Ground Return," E. A. Wolff, AF 19(604)-5198, 29 Feb 60, (69:26), Unclassified, AD 235 972.

A good summary of the principal theoretical and experimental investigations on terrain return. Results of ground- and sea-clutter measurement programs are compared, with perhaps more emphasis given to sea return (despite the title). Reviewed are reports from nine agencies. The variation of $\sigma°$ for sea surface with frequency, polarization, depression angle, and wind speed and direction is examined. Results include the following: $\sigma°$ varies from about λ^{-4} for calm seas to λ^{0} for rough seas for frequencies between 10 and 50 Gc. For calm seas, the return for vertical polarization can be as much as 20 to 30 dB greater than that for horizontal polarization. The variation of $\sigma°$ with depression angle can be 40 dB or more; the upwind-downwind ratio of $\sigma°$ can be as large as 10 dB at X-band; for depression angles less than 70°, an increase in wind speed from 5 to 25 knots can increase $\sigma°$ by more than 30 dB in the range from 15 to 35 Gc. For depression angles below 4°,

ELECTROMAGNETIC RESEARCH CORPORATION (CONT.)

5259 (Cont.)

indications are that $\sigma°$ varies as $W^{1.5}$ for horizontal polarization, and as $W^{2.0}$ for vertical polarization at frequencies of 6.3 and 35 Gc (W = wind speed in knots). (Ed: The comparisons on ground clutter are somewhat more limited.)

Theories reviewed include the corrugated-surface, drop, and facet theories of sea clutter and the slightly-rough-surface and thin-lossy-cylinder theories of ground clutter. Also discussed are several miscellaneous theories based upon hypothetical statistical descriptions of the surface, such as arrays of spheres. It was concluded that the facet theory appears to be a more satisfactory explanation of radar backscattering than either the corrugated-surface or drop theories. (See also following abstract.)

5260 Report CRC-5198-4 (Final Report; AFCRC-TR-60-127), "Investigations of Ground Clutter and Ground Scattering," M. Katzin, E. A. Wolff, and J. C. Katzin, AF 19(604)-5198, 15 Mar 60, (91:26), Unclassified, AD 235 971.

This report consists essentially of four parts: (1) A review of sea-clutter characteristics, including reflection interference phenomena and scattering by flat plates, with a report on experimental polarization data. (2) An examination of existing data on ground clutter to determine what sea clutter principles can apply. (3) An analysis of the polarization properties of targets, including development of a theorem which states that, for any given target and aspect, there exists an incident-field polarization which gives maximum echo and another which gives zero echo. (4) Discussion of methods for measuring the radar length tensor and a description of a typical radar system for measuring coherent ground scattering polarization.

The report does not give any original experimental data and no new major conclusions are offered; it does attempt to interpret underlying physical processes in the light of some theoretical approaches, especially the polarization matrix and reflection interference. (See also preceding abstract and Abstract 9190.)

ELECTRONIC COMMUNICATIONS, INC.

5261 Final Technical Report, "Investigation to Establish Design of Prototype Model Universal Portable Detector," DA 44-009 ENG-4799, 12 Mar 62, (84:0), Unclassified, AD 292 739.

Possible techniques for detecting land mines by means of radar were investigated experimentally. Monostatic and bistatic laboratory reflectometer measurements were made by the frequency-separation technique at S- and X-bands on rectangular and disk-shaped Lucite targets. Both sweep-frequency and short-pulse techniques were applied to buried targets. Cross-polarization was found to reduce background level as compared to transmitting and receiving elements with the same polarization. The short-pulse technique did not prove feasible as implemented.

5262 Final Report, "Radar Detection of Man in Clutter," DA 36-034 AMC-0117R, 14 Oct 63, (49:4), Unclassified, AD 224 658 formerly AD 347 687.

An L-band FM-CW radar was constructed to investigate a proposed technique for detecting the presence of a stationary man in vegetation. Since the cross-section of a point target as a function of frequency is different than that of an extended target such as clutter, it was assumed that by examining the return signal, the presence of a stationary man within an extended clutter area could be detected. Three variations of a breadboard radar were constructed and used in the

ELECTRONIC COMMUNICATIONS, INC. (CONT.)

5262 (Cont.)

investigation. Limited success was achieved, but the results are not sufficiently conclusive to ensure that a field-version radar would be worthwhile.

EMERSON AND CUMING, INC.

5263 Scientific Report 3 (AFCRC-TN-58-168), [No Title], AF 19(604)-2448, 26 May 58, (12:2), Unclassified, AD 152 405.

Work to demonstrate the usefulness of an Eaton lens. Techniques for constructing Luneburg lenses were used to make a 4π-steradian microwave Eaton-lens reflector 12 inches in diameter. The lens consists of 30 concentric shells, each about $\frac{1}{4}$ inch thick, and dielectric constants of the shells increase with shell diameter. The lens backscattered 6% to 15% of the power incident upon it.

EMERTRON, INC.

5264 Report QPR-1-5514 (Quarterly Progress Report 1), "Scattering of Electromagnetic Waves by Ultrasonic Beams," DA 36-039 SC-87236, 15 Sep 61, (30:-), Unclassified, AD 267 219.

(RC-3317) Efforts were made to determine the feasibility of non-line-of-sight microwave communication by scattering from ultrasonic radiation. Significant factors affecting the scattering of radio waves by sonic beams are discussed, including: changes in the refractive index of air, the angles of incidence and reflection of a radio beam relative to a sonic beam, the collimation or half-power beamwidth of the sonic beam, and distortion of a plane or spherical sonic wave by various meteorological phenomena. Sonic sources are reviewed, and source expanded. Experimental tests of a prototype forced-air vibrator were initiated in outdoor experiments aimed at measuring the scattering of a radio beam in the 30-34 Gc region by an ultrasonic beam in the 10-12 kc region.

FAIRCHILD ENGINE AND AIRPLANE CORPORATION

5265 Report 75R-18 (Final Report), "PADAR Flight Test Program. X-Band Radar Energy Terrain Reflection Coefficient Investigation," E. I. Newdale, G. H. Mattison, and R. W. Spacie, AF 33(616)-5773, 15 Nov 59, (27:2), Unclassified, AD 230 107.

Brief presentation of selected results from flight tests that were run to obtain data on ground reflection coefficient for forward-scatter at X-band. Observations were made of direct and terrain-reflected signals transmitted from one aircraft to another. Only three flights gave usable data, and it was concluded that further experimentation would be required to obtain quantitative measurements of reflection coefficients. The work was in connection with the PADAR (Passive Detection and Ranging) technique of measuring the relative position of a transmitting aircraft from another aircraft.

FOREIGN TECHNOLOGY DIVISION, AIR FORCE SYSTEMS COMMAND

5266 MCL-1394/1+2, "Disturbance of Radar Instruments Through Heavy-Sea Reflexes (sic)," J. Brauns and H. G. Moeller, 7 Sep 61, (21:0), Unclassified, AD 264 499.

Photographs of sea clutter on a PPI presentation were analyzed to determine an empirical relation for the decrease in intensity of sea clutter with range. The results seem to disagree somewhat with the common assumption of exponential

FOREIGN TECHNOLOGY DIVISION, AIR FORCE SYSTEMS COMMAND (CONT.)

5266 (Cont.)

decline. Theoretical analysis is presented to support the experimental data. (Ed: A poor translation.)

Note: This is an unedited rough-draft translation of a journal article, Abstract 7332J.

5267 MCL-1078/1+2, "Radar Echoes from Aurorae," B. A. Bagaryatskii, 26 May 61, (83:86), Unclassified, AD 259 575.

The reflection mechanism and basic physical characteristics of auroral reflecting formations are studied with data obtained from radars whose frequencies ranged from 30 Mc to 1 Gc. Four possible reflection mechanisms are mentioned: reflection from a regular surface bounding the ionization region, reflection from a sharp separation boundary, reflection from a narrow concentrated electron layer, and scattering or incoherent reflection from chance ionization irregularities. Basic features of auroral reflection are discussed briefly; included are reflection types, range, duration, and altitude, correlation of visual aurora and radar reflection, spatial distribution of reflection regions, and maximum elevation angles for reflections. The diurnal variation of reflections and their correlation with geomagnetic activity are discussed in some detail; a close relationship is reported between the occurrence of radar reflections and that of magnetic disturbances. The geometry of radar echoes and their relationship with features of sporadic ionization are also discussed at length.

Note: This is an unedited rough-draft translation of a journal article, Abstract 8382J.

5268 MCL-1322/1+2, "The Problem of the Effect of Variations in the Intensity of Cosmic Noises on the Diurnal Distribution of the Number of Meteor Reflections," L. P. Serafinovich, 13 Oct 61, (4:4), Unclassified, AD 265 723.

Diurnal variations in the intensity of cosmic noise will affect the sensitivity of radars used in studying the diurnal distributions of meteor observations, and hence need to be compensated for in records of observation rates. U.S. and other work is very briefly commented on, and it is concluded that a correction is needed in observations below 100 Mc.

Note: Unedited rough-draft translation of: Byulleten' Instituta Astrofiziki Akademii Nauk Tadzhikskaya SSR, (USSR), No. 27, 37-39 (1959).

5269 MCL-1338/1+2, "Bulletin of the Kazan University Astronomical Observatory," 23 Oct 61, (31:12), Unclassified, AD 265 729.

Of the two papers included, only the following is pertinent.

"A Survey of Radar Observations of Meteor Activity, Conducted at the Engel'gardt Astronomical Observatory from May 1956 through August 1958," Yu. A. Pupyshev (8:7).

A brief summary of the statistics of meteor observations made by the Observatory over a two-year period at wavelengths of 4.2 and 8.6 m. The distribution of the hourly rate of observations is shown with both diurnal and fortnightly smoothing, as is the relation between average echo duration and the F_2 and E critical frequencies.

Note: Unedited rough-draft translation of: Byulleten' Astronomicheskoy Observatorii Kazan'skogo Universiteta (USSR), No. 35, 1-23 (1960).

FOREIGN TECHNOLOGY DIVISION, AIR FORCE SYSTEMS COMMAND (CONT.)

5270 FTD-TT-61-85/1, "Radio Electronics in Investigations of the Cosmos," V. I. Siforov, 18 Jan 62, (5:1), Unclassified, AD 270 793.

A brief elementary account of meteor radar reflections, planetary radar reflection, and related topics. (Ed: Of little interest, although the translation is adequate.)

Note: Unedited rough-draft translation of: Radioelektronika v Issledovaniyakh Kosmosa, Izdatel'stvo Znaniye, Moscow, 41-44 (1960).

5271 FTD-TT-62-336/1+2, "Repulsion of Electromagnetic Waves by Plasma," V. I. Kurilko and V. I. Miroshnichenko, 27 Jul 62, (4:5), Unclassified, AD 284 095.

A brief discussion of the reflection of electromagnetic waves from plasma moving along a constant magnetic field in a non-dispersive dielectric. Integro-differential equations are used to define the field in the plasma. (Ed: The translation is poor.)

Note: Unedited rough-draft translation of: Ukrayina'kyy Fizychnyy Zhurnal (USSR) 6, No. 3, 415-16 (1961).

5272 FTD-TT-62-595/1+2+4, "The Question of Processing Radar Observations of Meteoric Echoes," V. P. Tsesevich, 27 Aug 62, (19:-), Unclassified, AD 286 620.

This report is concerned with the analysis of raw data on radar meteor observations to obtain information about the earth's meteoric influx. Several aspects of the mathematical calculations involved are discussed, but primary attention is given to the problem of determining and accounting for the beam pattern of the radar antenna. (Ed: Although rough, the translation is reasonably intelligible.)

Note: Unedited rough-draft translation of: Trudy Odesskogo Gosudarstvennogo Universiteta im. I. I. Mechnikova 149, 9-23 (1959).

5273 MCL-226/1+3+4, "Selected Articles from the Bulletin of the Committee on Comets and Meteors Under Astronomical Council of USSR Academy of Sciences," 20 Nov 62, (22:12), Unclassified, AD 292 219.

This document presents four short articles: (1) "Concerning an Error in Determining the Coordinates of a Meteor Radiant"; (2) "Tentative Results of Radar Observations of Meteors on λ = 10 Meters"; (3) Concerning the Problem Involved in Selection of a Transmitter of the Radar Station for Radio-Analysis of Meteoric Traces"; and (4) "Certain Features in Resonance Reflection of Radio Waves From Meteoric Traces." (Ed: Since all figures are omitted from the DDC-supplied copy, the document is of limited value.)

Note: Unedited rough-draft translation of: Byulleten' Komissii po Kometan i Meteoram Astronomicheskogo Soveta AN SSSR, No. 2, 34-49 (1958).

5274 FTD-TT-62-1215/1+2, "Fundamentals of Radar," A. G. Saybel', 15 Feb 63, (402:27), Unclassified, AD 298 779.

This document is a translation of an introductory general textbook on radar published in the USSR. It contains a 37-page chapter on the reflecting properties of radar targets, which includes elementary treatment of the scattering properties of several common targets: dipoles, flat surfaces, aircraft, etc. (Ed: While the translation is good enough so that the book can be read with profit, such standard material on radar fundamentals is preferably sought in the English literature.)

FOREIGN TECHNOLOGY DIVISION, AIR FORCE SYSTEMS COMMAND (CONT.)

5274 (Cont.)

Note: This is an unedited rough-draft translation of the Soviet text Osnovy Radiolakatsii.

5275 FTD-TT-62-1388/1+2+4, "An Investigation of the Fine Structure of the F Layer of the Ionosphere," N. T. Tsymbal, 5 Mar 63, (9:7), Unclassified, AD 298 650.

The turbulence of the F-layer of the ionosphere was studied by simultaneously measuring the angular dispersion of a scattered beam (from which a measure of the heterogeneity dimension can be calculated) and the ratio of specularly reflected energy to the scattered energy. Plots of the daily fluctuation in these quantities are shown for two seasons, as well as histograms of ionospheric velocities.

Note: This is an unedited rough-draft translation of: Akademiya Nauk Ukrainskoyi Rsr. Organizatsionnyy Komitet Po Provedeniyu Mezhdunarodnogo Geoficheskogo Goda. Mezhdunarodnyy Geofizicheskiy God Informatsionnyy Byulleten, No. 3, 19-23 (1961).

5276 FTD-MT-63-281; TT-64-71498, "Radar Visibility of Marine Objects," V. P. Peresada, 28 May 64, (170:50), Unclassified, AD 606 763.

This translated book reviews general scattering theory in detail and develops fundamental expressions (monostatic and bistatic) for cross-sections of a number of simple geometric shapes. Scattering from a group of reflectors and from corner reflectors are also considered. Methods of experimentally measuring cross-section are discussed, including rf, optical, and ultrasonic modeling.

Of particular interest is the extensive treatment of the effects which propagation across the sea or land has on scattering from objects thereon. The propagation theory of V. A. Fock is used, and tables and nomographs are included for certain calculations using dimensionless parameters which take into account the curvature of the earth and allow determination of an attenuation (propagation) function V. The object of this treatment is to allow σ to have the same interpretation for targets on a reflecting surface as it has for free-space targets; that is, for σ to be independent of the geometry by modifying the free-space radar equation by the multiplicative factor V^4 which contains all the geometrical factors. This procedure allows the value of V to be removed from a particular measurement case and a new value inserted for a different case when calculating detection range.

The concept of an "integral" propagation function is developed for objects extending upward from the surface and contrasted with the "local" function which exhibits the usual interference lobes. Both illuminated and shadow regions are examined. A very strong theoretical argument is made for use of the integral propagation function when viewing marine targets below some critical grazing angle, but experimental evidence for verification is scanty both in quantity and description.

Note: Edited machine translation of: Radiolokalsionnaya Vidimost' Morskikh Ob'ektov, Leningrad, 1961.

FORSVARETS FORSKNINGSINSTITUTT, KJELLER (NORWAY)

5277 Internal Report E-43 (Final Scientific Report; AFCRL-65-56), "A Study of Ionospheric Irregularities," P. Christophersen, AF 61(052)-500, 23 Oct 64, (128:22), Unclassified, AD 610 861.

Irregular structure and irregular motions in the F-layer of the ionosphere were investigated by examining the correlation between reflected radio waves that differ slightly in frequency. The first part of the report comprises a mathematical study of the reflection of electromagnetic waves from a spatially random medium. The correlation of two reflected signals of closely spaced frequencies is examined. It is determined that a critical distance exists beyond which frequency-correlation analysis can only provide the same information as spatial-correlation studies, but within which it provides additional information. Part 2 of the report gives the results of experimental studies made at 4 Mc. The frequency difference over which good correlation was evidenced was highly variable and lay between 10 and 100 kc. Part 3 describes the equipment.

Note: Part 1 is a reprint of Norwegian Defence Research Establishment Report 45, dated March 1963. DDC-supplied copy bears original cover and titlepage describing it as "Technical Report," and replacement cover and titlepage describing it as Final Scientific Report.

FRANKFORD ARSENAL

5278 Report TN-1101, "A Study of Polarization Characteristics of Plane Reflecting Surfaces," S. Y. Chang, 15 Jun 58, (30:1), Unclassified, AD 201 650.

A review of some fundamental theories of propagation of electromagnetic waves, and a study of polarization characteristics of plane reflecting surfaces directed toward applying polarization techniques to minimize clutter. Based on the solution of a general wave equation, fundamental properties are described for plane electromagnetic waves propagating from one dielectric medium to another. The reflection characteristics of a plane surface at the interface of two dielectric media or the boundary of a conductor are thoroughly discussed from the standpoint of amplitude reflection coefficients of two components of incident wave, one parallel and the other perpendicular to the plane of incidence. Calculation results indicate that at each reflecting surface, a 180° phase change occurs between the two components of the incident wave, when the angle of incidence equals the polarizing angle. A circularly polarized wave would be reflected from a conducting surface with sense reversed in a single reflection; for multiple reflections, however, the reflecting wave may retain the original sense of polarization. One possible method is suggested for minimizing ground-clutter problems through polarization techniques.

FRANKLIN INSTITUTE, LABORATORIES FOR RESEARCH AND DEVELOPMENT

5279 "Research on Radar Terrain Return Theory, Instrumentation, and Techniques," S. Charp, AF 33(038)-14320, Unclassified.

QER	Report No.	Date	Pages:Refs.	AD No.
27	P-2186-1-81	25 Mar 57	9:-	135 913
28	P-2186-1-84	25 Jun 57	66:-	144 168
29	P-2186-1-87	25 Sep 57	7:-	149 268
30	P-2186-1-90	25 Dec 57	4:-	147 727
31	P-2186-1-93	25 Mar 58	10:-	237 134
32	P-2186-1-96	25 Jun 58	15:-	237 132

FRANKLIN INSTITUTE, LABORATORIES FOR RESEARCH AND DEVELOPMENT (CONT.)

5279 (Cont.)

Note: For earlier reports in this series, see Abstracts 99-103, and 2115.

These reports describe the progress of a long-term program whose objectives were to describe statistical fluctuations of radar return and to develop theory and experiments for analyzing such signals, with the ultimate aim of providing a rapid, automatic system for recording and analyzing reflection data obtained from an airborne radar. No basic theory is covered in Reports 27-32, which mainly treat equipment and experimental development of the collection and analysis systems and some flight data and analyses.

The collection system consisted of a beacon-tracking radar (AN/APG-28), data-taking radar (a modified AN/APS-23), and a magnetic-tape recording system. The Correlation Function-Spectrum Analyzer Computer was evaluated and the average error for given sine waves was about 2.3% rms of full-scale. Return data were first taken over an area having closely cropped grass and computations were made with the system; subsequently, seven flights were made to collect data. The analysis system permitted discrimination of buildings from grass. All analytic results were considered preliminary data. Since the target area changes significantly during flight, data to be analyzed were collected in sections, each containing about 20,000 pulses.

5280 "Development of Broad-Band Electromagnetic Absorbers for Electroexplosive Devices," P. F. Mohrbach and R. F. Wood, N178-7913, Unclassified.

MPR	Date	Pages:Refs.	AD No.
P-B1857-6	31 Dec 61	25:2	272 791
P-B1857-7	31 Jan 62	24:1	274 239
P-B1857-8	not obtained		
P-B1857-9	not obtained		
P-B1857-10	30 Apr 62	42:7	278 661

This program was an investigation of electromagnetic radiation effects upon electroexplosive components. The most troublesome frequency range is below 10 Mc, where carbonyl iron is not acceptable as an absorber material. The ferrite family is investigated, along with other methods of protection. (See also next abstract.)

Report 6. An alternate expression involving complex permittivity and permeability quantities was derived for a computer program. Protective systems--electroluminescent, photoresistor, dissipative filters--were considered for absorption in the frequency range 20 kc to 40 Mc. Also discussed is an evaluation of C-27 ferrite between 40 and 236 Mc and a study of attenuation by ceramic dielectrics between 200 and 500 Mc.

Report 7. Methods of measuring attenuation (20 kc to 40 Mc) evaluated in this report resulted in measurement by low-frequency network techniques. Further work is reported on protective systems and evaluation of ferrites.

Report 10. Preliminary results from attenuation measurements are given, and the attenuation equation is derived for transverse magnetic propagating systems; a computer flow chart for attenuation appears in the appendix.

5281 "Development of Broad-Band Electromagnetic Absorbers for Electroexplosive Devices," P. F. Mohrbach and R. F. Wood, N178-8087, Unclassified.

FRANKLIN INSTITUTE, LABORATORIES FOR RESEARCH AND DEVELOPMENT (CONT.)

5281 (Cont.)

MPR	Date	Pages:Refs:	AD No.
P-B1981-1	31 Jul 62	15:2	283 949
P-B1981-2	31 Aug 62	20:2	287 196
P-B1981-3	30 Sep 62	25:0	290 310
P-B1981-(4-8)		not obtained	
P-B1981-9	31 Mar 63	20:4	406 324
P-B1981-10	31 Apr 63	not obtained	
P-B1981-11	31 May 63	13:1	411 812

These progress reports describe a continuation of work discussed in the preceding abstract, namely the search for materials suitable for detonation protection at frequencies below 100 Mc. Materials of the ferrite class, along with the support instrumentation and measurement program, receive particular attention. (Ed: No report giving final results or major conclusions was received for abstracting.)

Report 1. Briefly described are: (1) fabrication of ferrite-bimetal oxalates; (2) theoretical and preliminary experimental investigations of commercial ferrites; and (3) prevention of voltage breakdown of the rf absorber by inserting an interposed dielectric (high K ceramic) layer between the conductor and attenuation material.

Report 2. Attenuation in carbonyl iron samples was measured by techniques incorporating a single-stub tuner and line stretcher, phase shifting T networks, and T, π, and L networks.

Report 3. An attenuation measurement system employing the i-f substitution principle and single-stub tuner is discussed; material and dielectric studies are reported.

Report 9. Results of studying different methods of depositing a silver coating at a ferrite-metal interface indicate that a silver cyanide solution yields an excellent coating. Attenuation of a special K-24 ferrite toroid was 36 dB/cm at 1 Mc and 150 dB/cm at 200 Mc.

Report 11. Work centered on incorporating ferrites into an attenuator. Barrel- and axial-type attenuators were built in an effort to obtain high attenuation (30 dB) at 1 Mc, input resistance of at least 1 megohm, and breakdown voltage over 300 volts. For a small space, attenuation was the main problem and multiple-path devices were investigated.

FRIEDMAN (MORRIS D.), INC.

5282 ERD-TN-60-787, "On the Influence of the Reflection Region on Radiowave Scattering in the Ionosphere," N. G. Denisov, AF 19(604)-7387, Aug 60, (10:5), Unclassified, AD 244 803.

A theoretical treatment of the scattering properties of the ionosphere with irregularities in its structure. The effective scattering region in a linear ionosphere layer is investigated on the basis of the solution of the scalar wave equation. Diffraction by a fine irregular screen in the linear layer is analyzed, as is scattering by random inhomogeneities extended along the propagation direction.
Note: This is a translation of a journal article (see Abstract 7544J).

FRIEDMAN (MORRIS D.), INC. (CONT.)

5283 Report V-158 (AFCRL-570), "Correlation Function of the Amplitudes of Signals Scattered from an Absolutely Rough Screen," I. S. Vsekhsviatskaia and E. E. Tsedilina, AF 19(604)-8496, Jul 61, (6:8), Unclassified, AD 262 421.

The autocorrelation of the amplitudes of signals reflected from the ionosphere is studied under the assumption that the ionosphere comprises an absolutely rough reflecting screen, i.e., the scale of the inhomogeneity is small or comparable to the wavelength. It is assumed that the scattering screen possesses both random and directed (drift) motion. The autocorrelation function is found for this case and shown to be the product of the autocorrelations for the two limiting cases when there is only drift motion or only random motion of the scattering centers. The translation is good.

Note: This is a translation of a journal article (see Abstract 8006J).

5284 Report T-155 (AFCRL-707), "Plane Wave Incidence on a Selective Reflecting Surface," N. V. Talyzin, AF 19(604)-5969, Aug 61, (13:5), Unclassified, AD 262 527.

A mathematical treatment of the theory of reflection from a "selective surface" comprising an infinite plane array of separate dipoles. Normal incidence is assumed. The secondary field of the surface, the current excited in the dipoles, and reflection and transmission coefficients of the surface are derived. Translation is good.

Note: This is a translation of a journal article (see Abstract 7300J).

GENERAL APPLIED SCIENCE LABORATORIES, INC.

5285 Technical Report 317, "Back Scattering of a Plane Electromagnetic Wave from an Infinite Cylinder of Plasma with Small Axial Gradients and Arbitrary Radial Gradients of Electron Density--Normal Incidence," F. Lane, M. Abele, and S. Mariano, NOrd-18053, 19 Mar 63, (52:9), Unclassified, AD 410 371.

An approximate theoretical calculation of scattering from plasma cylinders for which the electron density varies arbitrarily in the radial direction and slightly in the axial direction. The incident wave is assumed planar with electric vector parallel to the axis. The solution is sought by extension of the theory for the simpler case of no axial variation, using an axial distribution of multipoles to represent the scattered field. Results of limited computer calculations are presented.

5286 Technical Report 387, "Effect of Transmitted Radiation Pattern on the Radar Return from a Plasma-Containing Infinite Cylinder under Oblique Illumination," F. Lane and S. Mariano, NOw-63-0637-c(FBM), 13 Mar 64, (66:0), Unclassified, AD 442 766.

Expressions for the backscattering by an infinite plasma cylinder are developed. The incident wave is of a general class; the electron density of the plasma is assumed to be uniform, and the incidence is oblique. However, the major axis of the transmitted pattern is assumed to intersect the center line of the cylinder. The feature of primary interest is the returned signal under oblique incidence. Under obliquely incident plane illumination, the uniform infinite plasma cylinder gives no backscatter; only normally incident plane waves give backscatter. The problem was to determine the effects of a non-plane-wave incident field on this backscattering for obliquely incident situations. Results obtained serve to answer this question, and to give the actual signal received

GENERAL APPLIED SCIENCE LABORATORIES, INC. (CONT.)

5286 (Cont.)

in terms of the original transmission pattern. A large number of graphs show power ratio vs. incidence angle for various values of parameters.

5287 Technical Report 394, "Back-Scattering by a Corrugated Plasma Configuration-Homogeneous Plasma, Normal Incidence, Long Corrugation Wave," F. Lane, S. Mariano, and G. Weilerstein, NOw-63-0637, 6 Jan 64, (54:2), Unclassified, AD 430 009.

Earlier work on backscatter from a plasma cylinder having non-uniform properties (see preceding abstract) is applied to a slightly different problem. The previous problem involved arbitrary radial variation of electron density and slight axial variation of that property. This report concerns a cylinder whose electron density is homogeneous but whose radius varies sinusoidally in the axial direction; the form is therefore that of a corrugated cylinder. The corrugations are long compared to cylinder radius and incident wavelength. A solution is obtained, using the same approach as before, under the same approximations, for normal incidence. About half the report is devoted to plots showing backscatter cross-section as a function of various parameters. The corrugated cylinder is taken to be an approximation to the wake of an oscillating vehicle.

5288 Technical Report 470, "Frequency Effects in the Scattering of Monochromatic Plane-Wave Electromagnetic Radiation by Temporally and Spatially Random Dilute Distributions of Electrons," F. Lane and T. Flack, NOsp-64-190-c(FBM), 16 Dec 64, (118:11), Unclassified, AD 461 649.

This report treats the scattered signal arising from plane-wave, monochromatic illumination of a succession of models of temporally and spatially random distributions of the electron density. This series of models was chosen so as to approximate, with increasing accuracy, the form and behavior expected of the nonsteady random electron distribution in a turbulent hypervelocity missile wake. The treatment is a single-scattering approach, limited to dilute electron distributions (plasma frequency small relative to signal frequency).

Primary interest is on finding the frequency content of the scattered signal which is available to a frequency-sensitive radar using techniques of generalized power-spectral representation appropriate to the frequency analysis of nonstationary random functions. It was found possible, for several of the more elementary models, to describe in detail the "support" (or frequency content) of the power-spectral density of the scattered signal without specifying in detail the actual distribution of power over the support domain. An exponential model is postulated and the form of the resulting frequency spreading is derived.

GENERAL ATRONICS CORPORATION

5289 Report 1110-278-2 (Final Report, Volume II), "Research on Fundamental Theoretical Radar Measurements," R. K. Gardner, J. J. Connolly, and G. Carley, Nonr-3660(00), ARPA Order 261-62, 30 Nov 62, (104:9), Unclassified, AD 418 227.

This document comprises only Parts III, IV, and V of the Final Report. Part III, "Theory of the Radar Surveillance of Extended Targets," J. J. Connolly (29:9): A theoretical analysis on the form of the radar return from extended targets. The classical approach to the problem of measuring extended targets is

GENERAL ATRONICS CORPORATION (CONT.)

5289 (Cont.)

based on an integral representation of target return. Many of its numerous mathematical complications may be circumvented by approaching the problem in terms of a tapped delay-line model. A condition is developed in the study which must be satisfied if measurements of extended-target parameters are to be theoretically possible. Part IV, "Sara," G. Carley (69:0): Scan-to-scan detection is analyzed using the minimum-cost approach of statistics. The theory presented shows that all past target information may be combined into one statistic which is updated after each scan, thereby reducing memory size. Part V is a summary relating the four preceding parts.

GENERAL ATOMIC DIVISION, GENERAL DYNAMICS CORPORATION

5290 GA-5617, "Scattering of Electrostatic Waves by Inhomogeneities in a Plasma," P. A. Sturrock, AF 29(601)-6366 and AF 49(638)-1321, 12 Jun 64, (18:-), Unclassified.

(BD-8074) A plane wave excited in an infinite uniform plasma preserves its identity, but a similar wave set up in an inhomogeneous plasma will change in the course of time. If the inhomogeneities are weak, one may analyze the excitation at any instant into plane waves, the normal modes of the homogenized plasma. The effect of inhomogeneities is to distribute the energy of a single initial plane wave among a spectrum of waves. By studying the time-development of this process, one can assign an equivalent damping coefficient. There is discussion of the possibility that inhomogeneities may, in this way, suppress an instability, such as two-stream instability.

GENERAL DYNAMICS/ASTRONAUTICS

5291 AE62-0030, "Re-Entry Physics Research. Semi-Annual Report," DA 04-495 ORD-3383, ARPA Order 39-62, 31 Dec 61, (17:3), Unclassified, AD 272 240.

The only portion of this program summary pertinent to reflectivity is a two-page summary of a study of wakes observed behind hypervelocity projectiles at 5 Gc.

5292 AE62-0218M (RDM 62-010), "Methods of Analysis of Microwave Scattering from Wakes of Hypervelocity Projectiles," W. R. Bradford and B. H. Siperly, DA 04-495 ORD-3112 and DA 04-495 ORD-3383, 12 Feb 62, (31:5), Unclassified, AD 273 817.

Interpretation of experimental results of ballistic-range tests conducted at 5 Gc with 20-mm blunt polyethylene projectiles. Detailed theoretical treatment is given of forward-scattered microwave signals from a dilute plasma column; ionized wake diameters are estimated from schlieren photographs of the flow field and related to backscattered microwave signals. Returns from perfect scattering rods are compared with returns from an overdense ionized wake. Decay-rate changes noted on microwave returns from an ionized wake may indicate the transition from laminar to turbulent flow. An indication of "roughness" and separation of scattering centers is shown. Theoretical analysis of forward-scattered microwave signals from an ionized trail led to an expression for charge per unit length. The model derived appears to be valid for dilute plasma columns for many microwave frequencies. Short mathematical appendices treat "Scattering of Microwave Power from a Point Source by a Dilute Plasma Column Electron Scattering Theory" and "Propagation within the Plasma."

GENERAL DYNAMICS/ASTRONAUTICS (CONT.)

5293 AE62-0483, "The Effect of the Secondary Electron Sheath on Radar Return," R. Abramoff and A. Kritz, AF 19(604)-5554, Feb 62, (11:2), Unclassified, AD 283 573.

This report concerns the scattering of an incident electromagnetic wave by a metallic body enclosed by a cold plasma sheath having constant electron density. It is shown that for an incident frequency between 10^3 and 10^5 Mc, sheaths having electron densities as high as 10^8 per cm^3 do not produce sufficient scattering to enhance radar return. Use is made of Pappert's results (R. A. Pappert, General Dynamics/Convair Report ZPh-062, 30 June 1960) for calculating the cross-section of a metal sphere with plasma sheath in the range from 10 to 200 Mc. These cross-sections are compared with the cross-section of the metal sphere alone, and the effect of the plasma sheath is seen to be most significant when resonant scattering is important.

5294 ERR-AN-225, "Microwave Interactions with Inhomogeneous Partially Ionized Plasmas," A. H. Kritz, DA 04-495 ARD-3383, ARPA Order 393-63, Nov 62, (27:25), Unclassified, AD 296 044.

This report reviews and compares several different methods of attack for studying the interaction of microwaves with inhomogeneous plasmas, and discusses several specific aspects of the problem. The first section examines the validity of the common technique of assuming an effective dielectric constant for the partially ionized plasma. Several analyses and approximations used by various workers are then outlined and the results reviewed briefly. Of particular interest is a section on the effect of variations in collision frequency. Although a constant collision frequency has generally been assumed in studying inhomogeneous plasmas, it is shown here that in many cases, particularly for highly ionized plasmas, the collision frequency profile may have an important effect on the interaction with microwaves. It is indicated that anomalous results which have been obtained in studying the reflection of microwaves from re-entry wakes may be a consequence of neglecting the variation of electron density and collision frequency.

Note: This report was presented as a paper at the 1962 Fall Meeting of the Western States Section of the Combustion Institute.

5295 BBE63-001, "Radial Electron Distributions in Wakes of Hypervelocity Projectiles," A. H. Kritz, DA 04-495 ORD-3383(Z), ARPA Order 393-63, Apr 63, (28:27), Unclassified, AD 403 296.

The problem of using microwave (5 Gc) techniques to study the wakes of hypervelocity projectiles is reviewed. It is shown that if the wake-ionization radius is considered to grow proportional to either the square root or cube root of distance behind the projectile, backscatter microwave data is inconsistent with the assumption that the radial electron distribution is uniform, parabolic, J_o-type, Gaussian, or exponential. In order for the linear charge density inferred from forward-scatter data to be consistent with that derived from backscatter data, the effective ionization radius has been determined as a function of distance behind the projectile, for Gaussian, uniform, and parabolic radial distributions. With data obtained from a series of shots at the NASA Ames Hypervelocity Ballistic Range, the effective radius for ionization is shown to decrease in the region of 50 body diameters to 200 body diameters behind the projectile.

GENERAL DYNAMICS/ASTRONAUTICS (CONT.)

5296 DBE64-064 (Final Report), "Re-Entry Physics Research," DA 04-495 ORD-3383(Z), ARPA Order 393-63, Nov 64, Unclassified.

(BD-8182) Efforts to measure sodium reversal temperatures and electron concentrations in the wakes of hypervelocity projectiles are described. Equations for analysis of microwave scattering from laminar wakes and limits on the validity of their application were examined. Dependence of scattering on experimental parameters (horn patterns, radial profiles of electrons in wake, displacements of the wakes from the probe axes, etc.) were estimated. Linear charge densities in wakes behind 20-mm blunt projectiles fired at approximately 20,000 ft/sec into air at approximately 2 mm Hg pressure (deduced from scattering of microwaves of two frequencies) are compared with theoretical values scaled from available calculations.

GENERAL DYNAMICS/CONVAIR

5297 Report MW-177, "Short Pulse Signatures of Ground Vehicles," R. R. Hively, AF 30(602)-2069, ARPA Order 46-59, 12 Oct 60, Unclassified.

(BD-391) A special backscattering range was set up at Convair-San Diego for observing and recording short-pulse radar signatures of ground vehicles. By utilizing radar pulses that are many times shorter than the target in physical length, it is possible to observe radar echoes from various scattering points on the target, and thus obtain a composite display of the relative returns from these scattering points versus time (range). This composite display of amplitude vs. time is referred to as the radar signature of that target. The purpose of these preliminary measurements was to determine how much difference exists in the short-pulse radar signatures of similar types of light vehicles.

5298 Report ZPh-030, "Fourth Semi-Annual Progress Report," AF 19(604)-5554 and Nonr-2683(00), ARPA Order 42-59, 30 Apr 59, Unclassified.

(BD-325) Contents include: "Electrogasdynamic Motion of a Charged Body in a Plasma," L. Kraus and H. Yoshihara; "Electromagnetic Reflection from an Ionized Layer in the Presence of a Conducting Wall," L. Kraus and R. M. Rhodes; "Further Studies on the Structure of the Satellite Wake," J. Holdsworth and S. Rand; and "The Flow About a Charged Body Moving in the Lower Ionosphere," R. R. Hunziker.

5299 Report ZPh-084, "Secondary Electron Emission from Satellite Surfaces," D. B. Medved, AF 19(604)-5554, ARPA Order 116-60, 17 Mar 61, (-:24), Unclassified, AD 274 799.

(BD-2658) The relevance of secondary electron emission to the charge accumulation and production of electron sheaths around satellites is reviewed as a function of altitude and ambient conditions. For $\gamma > 10^{-4}$, secondary electron emission can make an important contribution to these processes at altitudes below 250 km. Here γ is the coefficient of secondary electron emission in terms of electrons emitted per incident neutral particle. If photoelectric processes are considered, then for quantum yields greater than 10^{-2} and ultraviolet photon fluxes greater than 1 μw/cm^2, satellite surface charge will go positive in an ambient ionized medium where the electron density is less than 10^3. This corresponds to altitudes greater than 1000 km. For an infinite flat plate bombarded by neutral particles where the ejected electrons are monoenergetic, the electron density distribution follows the Langmuir-Childs law for the plane

GENERAL DYNAMICS/CONVAIR (CONT.)

5299 (Cont.)

parallel diode, where the equivalent of the second plate is given by the turn-around point of electrons trapped in the potential well formed by the positive surface-charge buildup on the satellite. Several numerical examples are discussed and it is shown that even for extremely small values of secondary electron emission coefficients, electron densities of $10^7/cm^3$ extending several centimeters out from the surface of the object are attainable. The electromagnetic scattering properties of an electron cloud of this nature surrounding a metallic object are discussed for ka $\ll$ 1.

5300 Report ZPh-094, "Microwave Studies of Flow Fields around Hypervelocity Projectiles," M. Schoonover, B. Siperly, and W. Short, DA 04-495 ORD-3112, 30 Jun 61, (27:4), Unclassified, AD 272 241.

The flow surrounding hypersonic bodies in the atmosphere was studied experimentally and theoretically to explain the observable properties of re-entry nosecones. The experimental studies were performed in a ballistic range using blunt plastic models at velocities up to 26,000 fps. The bodies and their wakes were observed with microwave equipment at 2 frequencies, as well as with a schlieren system and an ultraviolet detector. Approximately 300 microwave measurements of hypersonic projectiles were made. What appeared to be a transition from laminar to turbulent flow in the wake was detected at 1 mm Hg. Instrumentation and test procedure are described in detail.

The theoretical analysis required to compute the number of electrons per unit length of wake was completed. It was also shown theoretically that the electron concentration as a function of radial distance in the wake can be computed from microwave reflections at several frequencies. It is concluded that microwave radiation is a very sensitive means of detecting the shape of projectiles and the presence of ionization in the flow around them.

5301 Report ZPh-096, "The Microwave Diagnosis of a Column of Ionized Gas," J. R. Barthel, DA 04-495 ORD-3112, ARPA Order 39-59, May 61, (14:3), Unclassified, AD 257 972.

This report summarizes methods for determining the signal scattered from a column of ionized gas having known properties, for an assumed incident plane wave. Two models are treated: a homogeneous dielectric, whose dielectric constant is an arbitrary complex number; and a large number of independently scattering electrons, whose density may vary strongly in the radial direction and weakly in the axial direction. Also given is a method for solving the inverse problem, that of determining the properties of the gas column by measuring the forward- and backward-scattered signals (assuming negligible absorption).

5302 Report ZPh-102, "Re-Entry Research," DA 04-495 ORD-3112, ARPA Order 39-59, 30 Jun 61, (55:5), Unclassified, AD 272 274.

A compilation of abstracts of topical reports published between February and August 1961, concerning research in the following areas: equilibrium thermodynamic properties of high-temperature air and air with additives; fluid dynamics of wakes behind hypersonic bodies; relaxation processes in the upper atmosphere; shock-tube measurements of reaction rates in nitric oxide; theoretical and experimental evaluation of scattering cross-sections of electrons; numerical calculations of inviscid supersonic flow-fields; and measurements of microwave

GENERAL DYNAMICS/CONVAIR (CONT.)

5302 (Cont.)

characteristics of the wakes of hypersonic projectiles. Included is a brief summary of work accomplished and general conclusions.

GENERAL DYNAMICS/FORT WORTH

5303 Report FZE-222-1 (RADC-TDR-63-484), "An Analysis of the Polarization Capabilities of a Ground Plane Cross Section Range," A. W. Wren, Jr., J. A. Green, and C. M. McDowell, AF 30(602)-2831, 17 Oct 63, (67:9), Unclassified, AD 439 883.

This report is the first in a series of eight RAT SCAT (Radar Target Scatter Site) research reports; it contains a theoretical investigation of methods for obtaining circular-polarization measurements on a ground-plane RCS-measurement range. Some of the results are specialized with respect to the RAT SCAT facility; however, the analysis is applicable to any ground-plane range. Based on ray theory, the propagation equations for a ground-plane range are given. Using these equations, three alternate procedures for measuring the circular-polarization cross-sections are described: (1) measurement of the rectangular scattering matrix; (2) use of elliptical polarization; and (3) direct measurement of the ground-plane scattering matrix. The merits of each system are discussed with respect to the physical parameters of the range, and an experimental equipment design is suggested. It is concluded that the use of elliptical polarization is the most feasible method for determining the circular-polarization cross-section. For various dielectric constants and conductivities, curves and tables are given which relate soil-reflection coefficient (phase and amplitude) to grazing angle. A major portion of this investigation is reported in a symposium paper (see Abstract 5885).

Note: This document is a reproduction of Conductron Corporation's Report 32-1-F, revised 18 July 1963.

5304 Report FZE-222-2 (RADC-TDR-64-380), "Experimental Results of Circular Polarization and Scattering Matrix Measurements," B. A. Benn and C. C. Freeny, AF 30(602)-2831, Jun 64, (42:3), Unclassified, AD 605 520.

(BD-7821) This report describes results of experiments performed at the RAT SCAT Site, a ground plane radar cross-section range, to examine the operational feasibility of measuring arbitrary targets with circular polarization and of measuring linear scattering matrices. A calibration procedure compatible with the RAT SCAT facility is presented. Elliptical polarization was used to facilitate the establishment of circular polarization at the target point. Experimental data is presented on the magnitude of polarization degradation as a function of target size and time. Relative phase measurements, along with the necessary amplitude measurements, were used to determine the linear scattering matrix of a complex target. Finally, two annotated schemes compatible with present RAT SCAT equipment for obtaining the linear scattering matrix are described.

5305 Report FZE-222-3 (RADC-TDR-64-150), "A Theoretical Analysis and Experimental Results of a Frequency Stepping Method for Radar Scattering Measurements," J. W. Tucker, J. W. Jones, C. H. Fletcher, and W. P. Cahill, AF 30(602)-2831, Mar 64, (108:3), Unclassified, AD 601 387.

Cross-section patterns from complex targets typically exhibit violent oscillations as aspect angle is changed, due to changes in the relative phase between reflections from individual scatterers. This report describes a frequency-

GENERAL DYNAMICS/FORT WORTH (CONT.)

5305 (Cont.)

stepping technique in which radar frequency is changed from pulse to pulse, and which de-emphasizes and smooths these oscillations. The result is a pattern in which characteristics of individual scatterers are emphasized rather than interactions between scatterers. The technique also makes possible greatly improved range resolution, as a direct consequence of the wide bandwidth of the frequency-stepping waveform. An introductory section discusses the theory, first for a two-scatterer model, and then for an n-scatterer model. Much of the report is given over to description of instrumentation at the RAT SCAT range, and of frequency stepping measurements; results of the latter are said to agree closely with theoretical prediction.

5306 Report FZE-222-4 (RADC-TDR-64-317), "An Analysis of the Scattering Matrix Measurement Capabilities of a Ground Plane Radar Cross Section Range," R. A. Ross and C. C. Freeny, AF 30(602)-2831, Jun 64, (73:11), Unclassified, AD 605 519.

Presented in this report are methods for determining the scattering matrix, with emphasis on their application to a ground-plane range--the RAT SCAT range in particular. Also included are brief discussions on scattering-matrix formulations and their history. In general, the scattering matrix of a target may be established by one of three techniques: (1) amplitude and absolute-phase measurements; (2) amplitude and relative-phase measurements; and (3) amplitude-only measurements. The first of these requires transmission of two linear polarizations and reception of three; the second method calls for transmission of two and reception of four. However, the use of relative-phase measurements in method (2) allows for much simpler measurement techniques than does method (1), which requires absolute-phase measurements. Method (3) requires five independent measurements of magnitude plus two of sign.

The ground-plane range concept range is discussed in relation to the above methods of determining scattering matrices. It is concluded that the ground plane introduces errors which must be corrected for accurate measurement of the scattering matrix. It is recommended that instrumentation for matrix determination be confined to a relative-phase-and-amplitude system in order to avoid complex equipment arrangements.

5307 Report FZE-222-5 (RADC-TDR-64-382), "Radar Cross Section Target Supports: Metal Columns and Suspension Devices," C. C. Freeny and R. A. Ross, AF 30(602)-2831, Jun 64, (71:0), Unclassified, AD 606 122.

Described here is an analystical investigation of errors in cross-section measurement resulting from the use of a large, hydraulically actuated metal target support at the RAT SCAT site. Also discussed is an experimental investigation of a suspension target support in which a scaled ground-plane range was used to simulate low-frequency operation on the RAT SCAT range. Based on the two basic methods of reducing RCS of any target (coating the target with absorber material and shaping the target), three types of shield are recommended for reducing measurement errors encountered when the hydraulic-ram target support is used. The experimental program carried out on a scaled ground-plane range was primarily for the purpose of determining the cross-section of such conventional suspension supports as nylon. Also discussed are the support tower and the target-control pit area. An appendix describes a scaled CW 35-Gc ground-plane range built to simulate the full-scale RAT SCAT ground-plane range at 200 Mc.

GENERAL DYNAMICS/FORT WORTH (CONT.)

5307 (Cont.)

Note: The discussion related to the ground-plane range was presented in a symposium paper, see Abstract 5948.

5308 Report FZE-222-6 (RADC-TDR-64-381), "Radar Cross Section Target Supports: Plastic Materials," C. H. Smith, C. C. Freeny, E. F. Knott, and T. B. A. Senior, AF 30(602)-2831, Jun 64, (128:17), Unclassified, AD 608 252.

This report gives the results of studies of the scattering properties of cellular plastic materials in an effort to determine the best low-cross-section target support for a given application. A survey was made of the types, manufacturers, manufacturing processes, and physical and mechanical properties of available cellular plastic materials. Existing work on the use of such material was considered, and a theoretical study carried out of scattering by inhomogeneous media as it applies to cellular material. Also included are theoretical and experimental investigations of the frequency-dependence of backscattering from shaped blocks, and of surface-wave effects near a styrofoam beam.

5309 Report FZE-222-7 (RADC-TDR-64-397), "Investigation of Measurement Errors of the RAT SCAT Cross Section Facility," C. C. Freeny, T. R. Leeth, J. W. Jones, and M. F. Brust, AF 30(602)-2831, Jul 64, (112:5), Unclassified, AD 608 429.

Discussion of an analytical and experimental investigation carried out at the RAT SCAT RCS-measurement facility, in order to evaluate the nature of the fields in the target region and to investigate errors to be expected by use of these fields. The program was limited to investigations in the frequency range 1 to 10 Gc and dealt with errors involved in monostatic cross-sections, using horizontal and vertical polarizations. The investigations are grouped into four categories: near-field errors, background errors, extraneous-illumination errors, and calibration and instrumentation errors.

5310 Report FZE-222-8 (RADC-TDR-64-418), "Theoretical and Experimental Investigation of a Technique for Reducing Extraneous Signals in Radar Scattering Measurements," W. P. Cahill and C. C. Freeny, AF 30(602)-2831, Jul 64, (110:-), Unclassified, AD 607 136.

This report presents the results of an investigation of analytical and analog techniques for reducing the influence of target-support systems in cross-section measurements. Several electrical and mechanical requirements associated with these techniques were theoretically and experimentally investigated. An experimental system for analytically reducing the influence of target supports was tried out with a phase-measurement system and a digital computer added to an operational facility. Data was obtained by using the system to reduce the influence of the return of Styrofoam support columns, during the measurement at L-band of target spheres having diameters of 1/2, 5/8, 7/8, and 2 inches and of a 30°, 5.1-inch sphere-cone target. A cross-section error due to target supports of about 7 dB was reduced to about 1 dB with this system in one case.

5311 Report FZE-335 (Final Report on RAT SCAT), "Radar Target Scatter Site," AF 30(602)-2831, 29 Aug 64, (112:0), Unclassified.

Capabilities are described of the Radar Target Scatter Site (RAT SCAT), a ground-plane measurement range consisting of electronic equipment, buildings, vehicles, and other gear necessary for measuring cross-sections of a variety of

GENERAL DYNAMICS/FORT WORTH (CONT.)

5311 (Cont.)

full-scale aerospace vehicles. It is located on the alkali flats near Holloman Air Force Base, New Mexico. Pulsed radars operating over a frequency range of 100 Mc to 11,500 Mc can make bistatic and monostatic measurements.

GENERAL ELECTRIC COMPANY, DEFENSE SYSTEMS DEPARTMENT

5312 Report ASER 37-61, "Final Report. Generic Ranging Study. Volume 1," E. L. Berger, et al., DA 36-034-507 ORD-2925, 15 Feb 62, (451:18), Unclassified, AD 274 004.

This report documents an investigation of considerable size aimed at developing radars with improved clutter-rejection properties for use against ground targets for artillery and missile-fire control. The study exploited previous work at Frankford Arsenal which showed that monopulse techniques could provide (for the first time) good clutter rejection against typical ground targets. Clutter was simulated by a collection of scatterers vibrating randomly, and the response of a radar to a target in this clutter model was investigated by simulation on a computer. Within the limitations of the model, it was concluded that phase monopulse gives better clutter rejection than does amplitude monopulse, amplitude and phase monopulse, conical scan, or polarization.

GENERAL ELECTRIC COMPANY, HEAVY MILITARY ELECTRONICS DEPARTMENT

5313 RADC Trinidad Test Site Quarterly Technical Note, Vol. IV (RADC-TN-61-140), "A Study of Ionospheric and Lunar Characteristics by Radar Techniques," AF 30(602)-2244, 31 Oct 60, (119:57), Unclassified, AD 265 165.

Studies on the electron content of the ionosphere and the characteristics of radio waves reflected from the moon were performed with the RADC Trinidad 425-Mc radar. Objectives were to determine diurnal and seasonal variation of the electron content in the ionosphere and reflectivity characteristics of the moon's surface. The theory of analysis of lunar radar amplitude data for determining the electron content of the intervening medium is discussed, in particular the use of Faraday rotation. A discussion of lunar reflection laws emphasizes the Lambert and Lommel-Seeliger Laws for scattering from a rough surface. Also treated are the Doppler spectrum, and the statistical distribution of lunar-echo amplitude due to random fading and random fading plus a steady signal.

Most of the report is given over to results of experimental observations conducted at Trinidad using horizontally polarized transmission and simultaneous vertical and horizontal reception polarization. Also quantitatively described are the ratio of electron content above the F-layer maximum to that below, and equivalent slab thickness and scale height of the ionosphere. Lunar surface reflectivity characteristics are defined by graphs showing: backscattered power vs. radar-beam incidence angle; cumulative probability distribution of the total lunar cross-section; probability density function of the total lunar echo amplitude; Doppler frequency shift vs. time; autocorrelation functions and power-density spectrum of the total cross-section. Experimental and theoretical values are compared. Significant conclusions are: the front portion of the moon is comparatively smooth and is the region where specular reflection occurs; the back portion of the moon acts as a rough scatterer.

5314 RADC Trinidad Test Site Final Report, Volume V (RADC-TDR-61-194), "A Study of the Ionosphere Utilizing the Incoherent Scatter Technique," AF 30(602)-2244, 30 Jun 61, (86:57), Unclassified, AD 401 912.

GENERAL ELECTRIC COMPANY, HEAVY MILITARY ELECTRONICS DEPARTMENT (CONT.)

5314 (Cont.)

Analysis of ionospheric incoherent backscattering displaying Faraday rotational effects. After a review of the theory, in particular the frequency spectrum of incoherent backscatter, application of incoherent scatter to probing of the earth's atmosphere is examined. The ionospheric Faraday effect is next treated. Detailed analysis of experimental measurements obtained at the Trinidad Test Site concludes the report. It was found that for linear polarized transmissions, the incoherent backscattered signals received on orthogonal channels maximize at different ranges; these ranges correlate with theoretical predictions for the Faraday effect. Evidence is exhibited that the Faraday effect can be used to determine a calibration factor for converting relative electron density profiles deduced from incoherent backscatter into absolute measurements.

Ed: This work was also described in a later journal article: "Ionospheric Investigations by the Faraday Rotation of Incoherent Backscatter," G. H. Millman, V. C. Pineo, and D. P. Hynek, J. Geophys. Res. 69, 4051-64 (1 Oct 64); a reprint is available from DDC as AD 453 364.

5315 Interim Report (AFCRL-553), "Lunar Reflection Studies," AF 19(604)-6634, 6 Jul 61, (26:7), Unclassified, AD 264 312.

The changing multipath structure of the lunar propagation path distorts signals reflected from the moon in several ways. These distortions limit coherent bandwidth of the path and, hence, have been studied with the aim of determining the moon's properties as a reflector for communication purposes. Double-sideband suppressed-carrier transmissions were used at 915 Mc. Amplitudes of each sideband were recorded and cross-correlation coefficients were computed for various sideband frequency separations. Results show that the moon has a very low coherent bandwidth of less than 1000 cps if stringent requirements are placed on the required "quality" of the transmission path. Comparison with results for tropospheric scatter and reflections from the Echo satellite show that poor sideband correlation and resulting signal distortion are uniquely due to the moon.

5316 Final Report, Part I (AFCRL-62-300(I)), "Lunar Reflection Study," B. H. Claxton and R. E. Anderson, AF 19(604)-6634, 20 Mar 62, (97:42), Unclassified, AD 276 233.

A step-by-step approach is presented for designing a lunar-reflection communication system. It deals with factors which a potential user of the moon for communication purposes must consider before undertaking system design. Limitations of the moon path are shown together with suggested means for eliminating some of the distortion present on the reflected signals. Methods are given for calculating signal strength, moon availability, moon position, and libration, as well as antenna formulas and system noise-temperature calculations.

5317 Technical Note 11 (RADC-TDR-62-26), "Five Theoretical Plasma Studies," AF 30(602)-1968, Jun 62, Unclassified, AD 282 894.

(BD-4281) Included are:

"Electromagnetic Propagation in an Exponential Ionization Density."

Propagation of a plane electromagnetic (TE) wave into a plane stratified medium in which the ionization density varies as exp (z/z_o) is investigated. The solution of the wave equation appears as a combination of Bessel functions of

GENERAL ELECTRIC COMPANY, HEAVY MILITARY ELECTRONICS DEPARTMENT (CONT.)

5317 (Cont.)

imaginary order and complex argument, but the magnitude of the reflection coefficient (taken at $z = -\infty$) is given by the simple expression $\exp[-(4\pi z_o \cos\theta_i/\lambda) \times \tan^{-1}(\nu_c/\omega)]$. In this expression, θ_i is the angle of incidence, λ is the free space wavelength, and (ν_c/ω) is the ratio of electron collision frequency to the frequency of the field.

"Reflection of a TE Wave from an Inverse Parabolic Ionization Density."

A similar technique is used to determine the reflection coefficient for an electron density which varies as z^{-2}.

"The RF Reflectance of Plasma Sheaths."

This paper also appeared elsewhere, see Abstract 5321.

5318 Technical Note 22 (RADC-TDR-63-23), "Microwave Reflection from Shock-Produced Plasmas," G. W. Bethke and A. D. Ruess, AF 30(602)-1968, May 63, (45:31), Unclassified, AD 405 037.

Reflection measurements were made of very low power X-band microwaves axially incident on shock-produced xenon and krypton plasmas. The electron density profile at the advancing shock front was measured with a special high-resolution transverse 60-Gc interferometric probe. When compared with values from free-space theory, the measured reflection coefficients were always significantly lower, disagreement being greatest at the lowest plasma densities.

Note: This report was also published by General Electric Company, Missile and Space Division as Report R63SD77 (see Abstract 5322).

GENERAL ELECTRIC COMPANY, MISSILE AND SPACE DIVISION

5319 Report R59SD467, "Interaction of a Non-Uniform Plasma with Microwave Radiation," M. M. Klein, H. D. Greyber, J. I. F. King, and K. A. Brueckner, AF 30(602)-1968, 23 Nov 59, (-:7), Unclassified.

(BD-2086) An investigation of the interaction of microwave radiation with a non-uniform plasma for both normal and non-normal incidence. For normal incidence, the wave equation was solved by numerical integration; results show that, for a large range of collision frequencies, a major fraction of the incident radiation is absorbed by the plasma except for very sharp density gradients. The reflection coefficient has been obtained for a large range of the governing parameters; i.e., electron density gradient, wavelength of incident radiation, and collision frequency. For non-normal incidence, the radiation does not penetrate into the region of rapidly changing index of refraction so long as it is not too close to normal incidence; the ray path has therefore been calculated by geometrical optics, and absorption within the plasma has been obtained by the WKB method. Because the problem is more complex for the non-normal case, calculations are restricted to the short wavelength region. Results show that the absorption coefficient varies very little and remains large over a wide range of angles of incidence, but drops off rapidly beyond 45°.

5320 "Re-Entry Physics. Volume II--Propagation of Radio Waves in the Undisturbed Environment," H. G. Lew, Editor, DA 36-034 ORD-3187(RD), Dec 60, (167:41), Unclassified, AD 297 136.

GENERAL ELECTRIC COMPANY, MISSILE AND SPACE DIVISION (CONT.)

5320 (Cont.)

This document comprises four essentially independent studies.

"Effects of Atmosphere on Radio Wave Propagation," G. Millman and D. Leestma (69:17).

Theoretical analysis, including angular, range, Doppler, polarization, and amplitude variations, and attenuation.

"Effects of Natural Noise on Radio-Frequency Measurements," G. Millman, C. Roberts, and L. Humphrey (43:10).

Survey of the natural sources that contribute background noise to detection systems.

"Effects of Clutter on Radio Frequency Measurements," G. Millman and D. LaCombe (17:10).

Describes the basic properties of aurora, meteors, field-aligned ionization, ionosphere, and ground backscatter as contributors of clutter in detection systems.

"Radar Cross Section," S. R. Boyle (28:3).

Defines cross-section, briefly describes scattering from a sphere and from complex targets, tabulates cross-section formulas for twelve common geometrical shapes, and shows graphs of typical patterns for several of them.

5321 "RF Reflectance of Plasma Sheaths," L. S. Taylor, AF 30(602)-1968, [1962], (-:17), Unclassified.

(BD-2259) The wave equation for propagation of a TE wave in a plane stratified plasma sheath is solved by the method of series, and an expression for the reflection coefficient is abstracted. In special cases the series may be identified with certain known functions, and simple formulas for the reflectance are obtained. In general, however, the reflection coefficient appears as the ratio of complex infinite series.

Note: This paper also appeared elsewhere, see Abstract 5317.

5322 Report R63SD77, "Microwave Reflection from Shock Produced Plasmas," G. W. Bethke and A. D. Ruess, AF 30(602)-1968, Sep 63, (45:31), Unclassified, AD 417 556.

This document is identical with the General Electric report described in Abstract 5318.

5323 Report R63SD93, "Scattering of Radio Waves by Dense Turbulent Plasmas," L. S. Taylor, Nov 63, (15:6), Unclassified, AD 426 118.

An analysis of the scattering of radio waves by turbulent variations of free-electron density in a plasma. Second-order terms for the scattered field are included. An additional term (as compared to the first-order Born approximation) is found in the expression for the scattering cross-section; this term is proportional to $\gamma(\omega_p/\omega)^2$ where γ is a numerical factor determined by the scale of the turbulence.

GENERAL ELECTRIC COMPANY, MISSILE AND SPACE DIVISION (CONT.)

5324 Report R63SD58, "Some Aspects of Turbulent Scattering of Electromagnetic Waves by Hypersonic Wake Flows," K. T. Yen, Subcontract from Bell Telephone Laboratories under DA 30-069 ORD-1955, Dec 63, (-:32), Unclassified.

(BD-6156) Effects of flow intermittency, non-isotropy of turbulence structure, and finite width of a hypersonic wake on the frequency and aspect-angle dependence scattering cross-section are considered. It is also shown that electron-density fluctuations of a turbulent nature, in addition to those caused by "turbulence," will be produced by the intermittency behavior of turbulent wake flows. This fluctuation is found to depend on the mean electron-density distribution, and on Townsend's intermittency function. Phenomenological consideration of the physical process by which turbulent electron-density fluctuations are likely to be produced in hypersonic wakes yields an expression for fluctuation intensity in terms of the gradient of mean electron-density distribution, the intensity of the turbulent velocity fluctuation, and a turbulence scale of the turbulent velocity field. These considerations were applied to turbulent scattering by under-dense wakes. In contrast to ionospheric scattering, two contributions to the scattering cross-section are obtained: one arising from the intermittency phenomenon, which vanishes if the intermittency is omitted, and the other due to "turbulent" fluctuations. The frequency-dependences of these two contributions are seen to be quite different. It is further shown that flow intermittency, non-isotropy of turbulence structure, and finite width of the wake will introduce aspect-angle dependence into the scattering cross-section. A possible form of the total scattering cross-section for hypersonic wakes is also given. (See also Abstract 5325.)

5325 Report R64SD72 (Technical Information Series), "Effect of Turbulence Intermittency on the Scattering of Electromagnetic Waves by Underdense Plasmas," K. T. Yen, AF 04(694)-474, Nov 64, (45:13), Unclassified, AD 611 220.

In hypersonic wakes, intermittent mixing between the turbulent inner wake and the outer inviscid wake give rise to the "intermittency" phenomenon, an apparent increase in the amount of turbulence. This phenomenon is studied as a contributor to scattering from underdense plasma. Numerical results for the scattering cross-section with wavelengths from 1 to 100 cm were obtained by using correlation functions and a Gaussian mean electron-density distribution. Based on these results, some characteristics of the scattering cross-section such as its aspect-angle and frequency dependence are found to be significantly modified by the intermittency. In addition, the magnitude of the cross-section will always be larger if intermittency effects are considered, by many orders of magnitude in some cases. (See also Abstract 5324.)

5326 Report 58SD644, Revision 28, "Bibliography of Research and Development Reports, Revision 28. Weapon System 107 A-1, 107 A-2, N/Z TVX, PRESS and TRAP Program," AF 04(647)-617, AF 04(694)-222, and AF 04(694)-18, 30 Sep 63, (424:4200+), Unclassified, AD 461 241.

Listing of over 4000 reports issued by General Electric from 1955 through 1963 which pertain to the weapon-system programs of the title. Information given is General Electric report number, title, author, date, and classification; no index is included. A limited number of pertinent entries include some concerning re-entry vehicles and plasmas. The bibliography is revised every three months. (See also Abstract 5327.)

GENERAL ELECTRIC COMPANY, MISSILE AND SPACE DIVISION (CONT.)

5327 Report 63SD606-1, "Bibliography," AF 04(694)-18, AF 04(647)-617, and AF 04(694)-222, Mar 64, Unclassified--For Official Use Only.

A compilation of technical reports generated under General Electric Company's Advanced Re-entry Programs, comprising studies in re-entry technology and including body and wake flow fields, optical and radar observables, vulnerability and hardening, materials and associated system studies. Contains abstracts of Task Reports.

GENERAL ELECTRIC COMPANY, RE-ENTRY SYSTEMS DEPARTMENT

5328 Document 64SD701, "Preliminary Modifications to Cone-Sphere Theory," W. Sawchuk and L. R. Trotta, AF 04(694)-222 and AF 04(694)-486, 6 Jul 64, (19:4), Unclassified, AD 442 947.

The radar cross-section of the cone-sphere is examined. Mechanisms contributing to monostatic aspect-dependent scattering can be described analytically by: (1) a physical-optics formulation for the tip contribution and specular return at broadside and rear-on incidence; (2) travelling-wave antenna theory for the travelling wave induced on the illuminated surface; and (3) creeping-wave theory for surface fields in the shadow region. In treating the perfectly conducting case, the mathematics infer that the travelling wave over the cone surface launches a creeping wave of its own upon reaching either the cone-sphere join or the shadow boundary. Curves are presented to illustrate modifications to existing theory which show the join cross-section and the total cross-section as functions of aspect angle for various size and half angles.

5329 Document 64SD702, "Creeping Wave Contribution to Scattering from Lossy Spheres," W. Sawchuk and L. R. Trotta, AF 04(694)-222 and AF 04(694)-486, 6 Jul 64, (13:4), Unclassified, AD 442 946.

In this report, the creeping-wave contribution to the monostatic radar scattering cross-section of homogeneous spheres is graphed as a function of the index of refraction. Resolution of the field into physical-optics and creeping-wave contributions follows from the application of the Watson transformation to the exact Mie-series solution for the sphere. The seven graphs included, arranged in order of increasing index of refraction, represent sample data from a larger compilation which was to be published at a later date. The present approach has a twofold purpose: to provide analytical insight into the creeping-wave return, and to determine the minimum values of refractive index which will isolate the inner metallic core of a material-clad, perfectly conducting sphere. The latter values are determined by comparing the present solution with the concentric-sphere problem, wherein the inner radius is adjusted until the two solutions are approximately equal. The difference in radii, at this point, gives the minimum thickness of absorbing material necessary to reduce the cross-section. These values can then be applied directly to the cone-sphere.

GENERAL MILLS, INC.

5330 Report 1915 (RADC-TR-59-233), "Paraballoon Antenna Materials Study," J. H. Nash, F. J. Bollag, J. Hornsby, Jr., and R. C. Wood, AF 30(602)-1940, 1 Dec 59, (85:-), Unclassified, AD 233 013.

This study deals with the investigation of microwave-reflective, coated fabrics suitable for use in the manufacture of paraballoon antennas. Of several types investigated, the best was a base fabric of Dacron with a deposited coating of silver to make the reflective agent, and coated with a primary coating of Formvar and a final coating of Hypalon.

GENERAL MILLS, INC. (CONT.)

5331 Report 2149, "Large Passive Satellite Study. Volumes I and II," Nonr-(3245)(00)(X), 21 Feb 61, (200:52), Unclassified, AD 273 068.

This study was concerned with the design of large passive satellites for use as communication reflectors. Initial attention was restricted to spherical reflectors on the order of 1000 ft in diameter, but the program was later broadened and a variety of configurations examined. Besides questions of reflectivity, the work covered such topics as the effect of gravitational, radiation, and electromagnetic forces, deformations of the reflector surface, and the intensity distribution of the solar spectrum. Directional reflectivity properties were studied for spherical and polyhedral reflectors having specular, blistered, wrinkled, and fibrous skins; also considered were reflectors having dipoles, slots, or spirals on the skin. A theoretical study examines the possibility of achieving Lambert's Law scattering for microwaves.

Note: The DDC-reproduced copy of this document includes both Volumes I and II. Volume I comprises the theoretical studies discussed above, and Volume II examines a variety of topics relating to design and packaging.

5332 Report 2245, "Communication via Artificial Scatterers Placed below the Ionosphere," H. Raabe, S. Steinberg, S. P. Jones, et al., Nonr-1589(24), 1 Dec 61, (103:11), Unclassified, AD 623 050.

The possibility was investigated of creating a stable, efficient scatter-propagation communication link below the ionosphere which would be free from interruption by ionospheric storms. Such a link is presently possible by using a high-flying aircraft as a relay station, but this is expensive and cannot be initiated rapidly enough to be of use during sudden storms, which may last only half an hour. The work reported concerned two prime questions: what will do the job of scattering, and how can the scatterers be placed in the proper position and maintained there? A system is developed, which consists of a number of tuned dipoles tied together such that the scattered energy from each is in phase at the receiver. Because of the coherence effect, only a few dipoles are needed and it will be feasible to consider using only one dipole network; this network could be either suspended from a balloon or printed on its surface. Delivery by rocket appears feasible. Spheres were also considered as scatterers.

5333 Report 2353, "Communication via Artificial Scatterers. Phase II," W. Grosz, L. Flink, T. O'Malley, et al., Nonr-1589(24), 15 Dec 62, (130:13), Unclassified, AD 406 835 or AD 401 672.

The feasibility of establishing an effective scatter-propagation communication path through the use of artificial devices placed somewhere below the ionosphere was examined. Investigations were concerned with a frequency range of 1 Mc to 20 Gc. Three major approaches were considered: scattering by coherent grating arrays deployed in the atmosphere; use of active repeaters placed on the ocean surface; and scattering by a cloud of randomly oriented artificial scatterers in the atmosphere. In this report, the theory of forward scattering from nonresonant diffraction gratings is developed and applied to the case of a balloon-supported array. A field test of a balloon-borne array of conductive sheets is described. Forward scatter from a cloud of conventional chaff is analyzed, and a few alternative scatterers are briefly mentioned.

GENERAL MOTORS CORPORATION, DEFENSE RESEARCH LABORATORIES

5334 Technical Report 62-209B (Hypervelocity Range Research Program), "Radar Absorption Effects Measured in a Flight Physics Range," H. M. Musal, Jr., P. E. Robillard, and R. I. Primich, DA 04-495 ORD-3567, ARPA Order 347-62, Dec 62, (66:8), Unclassified, AD 294 465.

This report describes preliminary measurements of the head-on radar cross-section of both copper spheres and plastic cylinders with copper-covered hemispherical noses. First the conventional theoretical approach to radar absorption is outlined; in the simplest model it is assumed that a metallic sphere is uniformly coated with plasma, the properties of which are those at the stagnation point of the body under the particular flight conditions of interest. The backscatter cross-section of this model is obtained by a geometrical-optics approach. It is indicated that, if the diameter of the sphere is on the order of several wavelengths, it is useful to consider a one-dimensional problem in which the sphere and its plasma coating are replaced by a flat metal plate covered with a uniform slab of plasma. Finally, results obtained using this approach are compared with calculations obtained from a rigorous wave solution of the same problem. It is concluded that, for the approximations made, the geometrical-optics approach is sufficiently accurate.

The experimental program and results are described. Operating frequencies were 35 and 70 Gc, air pressure in the ballistic range in all cases was 10 mm Hg, and velocities ranged from about 10,000 to 20,000 fps, within which range significant absorption phenomena occurred. In the comparison with theory, anomalous absorption behavior is noted and possible causes are discussed.

5335 Technical Report 62-209I (Hypervelocity Range Research Program), "Transmission and Reflection Coefficients of Uniform Plasma Slabs as a Function of Plasma Frequency, Collision Frequency and Thickness of the Slab," S. Zivanovic, DA 04-495 ORD-3567, ARPA Order 347-62, Dec 62, (26:5), Unclassified, AD 294 467.

Known analytical expressions for transmission and reflection coefficients for a plane wave perpendicularly incident on a uniform plasma of finite thickness are used to compose a set of polar plots showing these coefficients as functions of plasma and collision frequencies and thickness of the plasma slab.

5336 Technical Report 62-209J (Hypervelocity Range Research Program), "A Numerical Method for the Determination of the Transmission and Reflection Coefficients of a Non-Uniform Plasma Slab," S. Zivanovic, DA 04-495 ORD-3567, ARPA Order 347-62, Dec 62, (37:8), Unclassified, AD 294 466.

Transmission and reflection coefficients are determined for a plasma slab whose electron density and collision frequency vary only in the direction of propagation, with initial conditions given on the interfaces of the slab and adjacent media. The wave equation for this case is an ordinary linear differential equation of second order for which no general solution exists, although there are many particular solutions. This report describes a method of numerical solution using a computer; the approach taken is to represent a given plasma slab by a two-by-two matrix analogous to the similar method in network theory. Cascading of plasma slabs, terminating them with conductive walls, or treating the semi-infinite plasma can all be carried out with the same basic integration program.

GENERAL MOTORS CORPORATION, DEFENSE RESEARCH LABORATORIES (CONT.)

5337 Technical Report 62-209K (Hypervelocity Range Research Program), "Transmission and Reflection Coefficients of a One-Dimensional Plasma Slab with Exponential and Parabolic Electron Density Distribution," S. Zivanovic, DA 04-495 ORD-3567, ARPA Order 347-62, Dec 62, (41:1), Unclassified, AD 294 463.

Transmission and reflection coefficients are obtained for a one-dimensional plasma slab with exponential electron density distribution following two separate approaches. The first involves calculation, using functions which are analytic solutions of the wave equation, while the second uses the plasma matrix coefficients, which are obtained by direct integration of the wave equation (the method of Report TR-62-209J above). The latter is found much preferable when only numerical results are needed. The second method is also applied to a parabolic distribution. Curves are given which represent transmissions, reflection, and absorption coefficients for both distributions with various values of peak plasma frequency, collision frequency, and slab thickness.

5338 Technical Report 62-209L (Hypervelocity Range Research Program), "Scattering of Electromagnetic Waves by a Plasma Cylinder," J. A. Fejer, DA 04-495 ORD-3567, ARPA Order 347-62, Dec 62, (22:14), Unclassified, AD 294 473.

A theoretical study of the scattering of electromagnetic waves by a plasma cylinder, assuming that the motion of positive ions can be neglected. The differential equations are first established for the general case that the unperturbed electron density is a continuous function of radial distance from the cylinder axis, and then solved analytically for the special case of the homogeneous cylinder. Expressions are derived for the intensity of the scattered field and for the resonant frequencies of the homogeneous cylinder. This theory predicts an isolated resonance at $1/\sqrt{2}$ times the plasma frequency (ω_p), plus a cluster of closely spaced resonances above ω_p, whereas experiment has shown that the higher resonances are much more widely spaced.

Numerical solutions are obtained for two specific cases of an inhomogeneous plasma cylinder comprising an inner core in which electron density is constant, and an annular sector in which density drops linearly with radius to an outer boundary where it goes abruptly to zero. These solutions show increased spacing of the higher resonances, and are in qualitative agreement with experimental results obtained on a gas-discharge column. Thermal motion of the electrons is approximately taken into account in the calculations.

5339 Technical Report 62-213 (Hypervelocity Range Research Program), "Report on Instrumentation, Calibration, and Data Reduction Methods," W. L. Koch and others, DA 04-495 ORD-3567, ARPA 347-62, Dec 62, Unclassified.

(BD-3989) This report is intended as a handbook, covering such fields as flight kinematics, optical radiation, microwave phase shift and attenuation, and CW Doppler radars to measure the radar cross-section of hypersonic models.

5340 Technical Report 63-217A (Hypervelocity Range Research Program), "On the Theory of the Radar-Plasma Absorption Effect," H. M. Musal, Jr., DA 04-495 ORD-3567(Z), ARPA Order 347-63, Jul 63, (185:32), Unclassified, AD 421 889.

A brief review of hypersonic aerodynamics, chemical and plasma physics, and electromagnetic scattering phenomena involved in plasma effects on radar cross-

5340 (Cont.)

sections. It is shown that the effect of the plasma sheath on the cross-section of a hypersonic body can be considered separately from the effect of the plasma trail left behind the body. Several theoretical models of scattering from plasma-covered bodies are formulated and analyzed; results show that both absorption and enhancement effects could be caused by the plasma sheath.

Experimentally measured absorption and enhancement are both significantly greater than theoretical; possible reasons for these discrepancies are discussed. It is concluded that the physical mechanisms causing absorption and enhancement are not completely understood, and several possible additional factors are suggested for incorporation into more advanced theoretical models. Fifteen appendices cover backscatter phenomena from various objects such as lossy dielectric-coated metallic spheres and plates; also treated are the electromagnetic properties of plasma.

5341 Technical Report 63-217B (Hypervelocity Range Research Program), "Millimeter Radar Techniques for Studying Plasma Effects Associated with Hypersonic Velocity Projectiles," P. E. Robillard, H. M. Musal, Jr., and R. I. Primich, DA 04-495 ORD-3567(Z), ARPA Order 347-63, Jul 63, (41:5), Unclassified, AD 415 180.

The head-on cross-section of plastic cylinders with copper-covered hemispherical noses was measured at 35 and 70 Gc. In a brief outline, the main features of the radar absorption effect are discussed in relation to a greatly simplified model of a blunt re-entry vehicle. The relationship of radar frequency, plasma properties, body shape, and flight characteristics to the maximum absorption conditions are indicated. Some related radar scattering theories are also briefly mentioned. The experimental program is discussed in some detail. Comparisons between experiment and theory showed two distinct discrepancies: the maximum absorption measured was significantly greater than that predicted by simple theory, and significant increases in cross-section were noted for which the simple theory offers no explanation.

Note: This report was originally presented as a paper at the Millimeter and Submillimeter Wavelength Conference at Orlando, Florida, in January 1963.

5342 Technical Report 63-217C (Hypervelocity Range Research Program), "Millimeter Wavelength Focused Probes and Focused, Resonant Probes for Use in Studying Ionized Wakes Behind Hypersonic Velocity Projectiles," R. I. Primich and R. A. Hayami, DA 04-495 ORD-3567(Z), ARPA Order 347-63, Jul 63, (51:18), Unclassified, AD 413 158.

Strongly focused microwave beams are used as a plasma diagnostic tool in determining the magnitude and spatial distribution of ionization behind hypervelocity projectiles in a flight range. The design philosophy of such focused probes is outlined and specific details of 35 and 70 Gc probes are given, together with typical results.

5343 Technical Report 63-217G (Hypervelocity Range Research Program), "A Comparison of Several Approximations for the Determination of Plasma Layer Properties from the Measured Electromagnetic Transmission Coefficient," S. V. Zivanovic, H. M. Musal, Jr., R. I. Primich, and J. Allen, DA 04-495 ORD-3567(Z), ARPA Order 347, Dec 63, Unclassified.

GENERAL MOTORS CORPORATION, DEFENSE RESEARCH LABORATORIES (CONT.)

5343 (Cont.)

(BD-6287) Several commonly used approximations of the transmission coefficient of a uniform plasma slab are critically examined and compared with a new approximation developed in this report. Following a discussion of the desirability of measuring the transmission coefficient of a plane slab as opposed to the reflection coefficient, various approximate expressions for the transmission coefficient are reviewed in relation to the new approximation. This new approximation has two major features. First, the normalized plasma frequency Ω_p' and normalized collision frequency Ω_c' as determined from the approximate formulas agree within a few percent with the exact values over most conditions of interest. Second, Ω_p' and Ω_c' are given by simple algebraic expressions which can be easily incorporated into digital-computer programs. All approximations considered are for a loss-free plasma, and an underdense plasma.

5344 Technical Report 63-224 (Hypervelocity Range Research Program), "A Broad Survey of Free-Flight Range Measurements from the Flow about Spheres and Cones," R. I. Primich and M. Steinberg, DA 04-495 ORD-3567(Z), Sep 63, (43:23), Unclassified, AD 427 050.

Free-flight measurements of the flow about both non-ablating and ablating spheres, sphere-capped cylinders, and cones are reported. Included are microwave measurements of wake ionization, head-on radar cross-section measurements, backscatter cross-section measurements of turbulent trails, and measurements of precursor ionization. Radiation results are presented for non-ablating spheres and the effect of contaminants, and sphere and cone results are compared. The status of the head-on radar results which include anomalous absorption is discussed. Precursor ionization ahead of non-ablating spheres has been identified and attributed to photoionization. Results of both schlieren and radar systems, which involve transition from laminar to turbulent flow and scattering from turbulent wakes, are compared. For cones, conditions cover velocities up to 22,000 fps and pressures up to 150 mm Hg, while for spheres, velocities range up to 24,000 fps and pressures up to 300 mm Hg.

5345 Contract Technical Note 64-01 (Hypervelocity Range Research Program), "CW Radar for Measuring Head-On Radar Cross Section of Free-Flight Projectiles. I. Antenna for Simultaneous 35 and 70 Gc Operation," P. E. Robillard and W. E. Blore, DA 04-495 ORD-3567(Z), ARPA Order 357-63, Jul 64, (10:4), Unclassified, AD 444 070.

Brief description of a non-time-sharing multiplex antenna system which permits two CW beams to be simultaneously transmitted coaxially with a minimum of interaction.

5346 Contract Technical Note 64-02 (Hypervelocity Range Research Program), "The Radar Absorption Effect Caused by Very Thin Plasma Sheaths," H. M. Musal, Jr., and W. E. Blore, DA 04-495 ORD-3567(Z), ARPA Order 357-63, Jul 64, (15:9), Unclassified, AD 444 071.

A more advanced theory is presented to explain the observed anomalous absorption caused by very thin plasma layers covering blunt metallic bodies. In essence, it is shown that the anomalous absorption may be a diffraction effect caused by the gradient of electron density in the sheath around the body; that is, the effect occurs when the body is only partially covered by an overdense

5346 (Cont.)

plasma sheath. This plasma layer can be very thin compared to λ and still significantly decrease the cross-section. The strong absorption observed experimentally is correctly predicted by this theory, but accurate verification of all details of the behavior as a function of ambient air density and body speed awaits more detailed computations. Several graphs show theoretical cross-section of a metal sphere partially covered by a plasma layer as a function of size, thickness, and properties of the layer.

Note: This report is a reprint of a paper presented at the 17th AMRAC (Anti-Missile Research Advisory Council) meeting held at the United States Naval Postgraduate School in Monterey, California on 27-29 April 1964.

5347 Technical Report 64-02J (Hypervelocity Range Research Program), "Millimeter Radar Instrumentation for Studying Plasma Effects Associated with Hypersonic Flight," H. M. Musal, Jr., R. I. Primich, W. E. Blore, and P. E. Robillard, DA 04-495 ORD-3567(Z), ARPA 357-63, Aug 64, (13:8), Unclassified, AD 449 823.

Description of a cross-section measurement range employing two CW Doppler radars which operate at 35 and 70 Gc. The radars are used to measure the nose-on backscattering cross-section of projectiles in flight, at speeds up to 23,000 fps, through a chamber in which ambient pressure can be maintained from one atmosphere down to 1 mm Hg. The radars operate simultaneously with a common-beam axis by use of a wire-grid beam splitter (see Abstract 5345). An important feature of each radar system is a Doppler-signal simulator, which provides absolute calibration of each radar so that dynamic cross-sections of projectiles in flight can be measured to within ± 1 dB relative to a square wavelength.

An experimental program is described in which these radars were used to measure the changes that occur in the cross-section of hypersonic projectiles due to their highly ionized flow fields. It is shown that a thin layer of over-dense plasma spreading from the stagnation point around the nose of the projectile causes electromagnetic diffraction and absorption, both of which decrease back-scattering.

Note: This report is a preprint of a paper presented at the First International Congress on Instrumentation in Aerospace Simulation Facilities, held 28-29 September 1964 in Paris.

5348 Contract Technical Note 64-05 (Hypervelocity Range Research Program), "Electromagnetic Wave Scattering from Dielectric-Coated Metal Bodies," H. M. Musal, Jr., DA 04-495 ORD-3567(Z), ARPA Order 357-63, Aug 64, (21:4), Unclassified, AD 448 062.

The usual physical-optics approach to the calculation of radar cross-section for a metal body is modified to include the effect of a thin dielectric coating over the metal surface. ("Thin" is here defined as a thickness small compared to the radius of curvature of the metal surface but not necessarily thin compared to wavelength.) Spatial variation in the dielectric, both parallel and normal to the metal surface, is allowed. The approach accounts for phase and amplitude perturbations caused by the dielectric. Depolarization of the backscattered wave is considered, and the theory is applied to specific examples involving a dielectric-coated metal sphere, a cone, and a cone-sphere.

GENERAL MOTORS CORPORATION, DEFENSE RESEARCH LABORATORIES (CONT.)

5349 Contract Technical Note 64-06 (Hypervelocity Range Research Program), "Electromagnetic Wave Reflection from a Metal-Backed Non-Uniform Plasma Layer for Non-Normal Incidence," H. M. Musal, Jr., DA 04-495 ORD-3567(Z), ARPA 357-63, Aug 64, (13:2), Unclassified, AD 449 859.

Documentation of a technique for calculating the reflection coefficients for a plane electromagnetic wave incident obliquely on a metal wall covered with a non-uniform plasma layer. It is assumed that plasma frequency and electron-collision frequency vary spatially only in the direction normal to the wall. The plasma layer is treated as a lossy dielectric material. The arbitrarily polarized incident wave is assumed to be composed of transverse electric (TE) and transverse magnetic (TM) modes, and the reflection coefficient for each mode is found separately.

5350 Contract Technical Note 64-08 (Hypervelocity Range Research Program), "A Numerical Investigation of the Validity of the Born Approximation for Determination of the Reflection Coefficients of Underdense Plasma Slabs," S. Zivanovic, DA 04-495 ORD-3567(Z), ARPA Order 357-63, Oct 64, (17:5), Unclassified, AD 450 205.

The validity of the Born approximation for determining the reflection coefficients of plasma slabs is numerically examined for the uniform underdense slab, and a slab with a sinusoidal perturbation superimposed on a constant electron density. The regions of validity are discussed in each case. It is found that, depending on the required accuracy, the Born approximation can be a very satisfactory approach for studying reflection from underdense plasmas up to plasma frequencies of about 0.2 the incident frequency. Its chief merit lies in its simplicity and ability to handle nonuniform plasmas.

5351 Contract Technical Note 64-09 (Hypervelocity Range Research Program), "Effect of Ablation Material on Observables from a Slender Cone in a Free-Flight Range," L. N. Wilson, R. A. Hayami, E. W. Evans, et al., DA 01-021 AMC-11359(Z), ARPA Order 357-63, Oct 64, (51:6), Unclassified, AD 450 181.

Brief treatment of radar scattering from wakes behind slender, hypersonic cones. Both unseeded (clean) and seeded wakes were observed at 35 Gc; an ablation ring of one of three materials was used near the base of the cone for seeding. Graphs relate received backscattered power P_r to transmitted power P_t as a function of distance behind the body in body diameters. Results show peaks in P_r/P_t of about -50 dB near the base, decreasing to about -100 dB at ten diameters behind the base.

5352 Contract Technical Note 64-11 (Hypervelocity Range Research Program), "CW Oblique Radar for Studying the Scattering Characteristics of Ionized Wakes: I. 35-Gc Radar Without Separate Phase- and Amplitude-Measuring Capabilities," P. Robillard, DA 01-021 AMC-11359(Z), ARPA 357-63, Oct 64, (19:0), Unclassified, AD 450 192.

This report deals with the application of a CW oblique radar to the scattering characteristics of ionized wakes. The radar has been used in conjunction with the GM DRL free-flight range. The basic radar instrumentation used, a 35-Gc CW Doppler radar, was the same as that used to measure nose-on radar cross-section of hypersonic projectiles (see Abstract 5347). A number of firings were studied with the equipment and wake transitions were observed under appropriate conditions.

GENERAL MOTORS CORPORATION, DEFENSE RESEARCH LABORATORIES (CONT.)

5352 (Cont.)

It was concluded from these initial observations both that strong signals can be detected from wakes produced by hypersonic projectiles fired on a free-flight range, and also that wake transition can be observed through the use of high-resolution antennas.

GENERAL TELEPHONE AND ELECTRONICS LABORATORIES, INC.

5353 Final Report (RADC-TDR-63-213), "Investigation of Modulations Arising from Interaction of Electromagnetic Waves with a Plasma," S. Tetenbaum and E. Barrett, AF 30(602)-2477, 15 Apr 63, (132:15), Unclassified, AD 411 571.

This report describes two separate investigations. The first involves theoretical and experimental study of modulations arising from nonlinear interaction of electromagnetic waves with a free-space helium magnetoplasma slab. Detailed results are presented of the generation of second harmonic and sum and difference frequencies for low-level incident signals at X- and K-bands. The effect of high-level incident waves was determined empirically. In addition, preliminary experimental data are given of the free-space microwave Luxembourg Effect. Except for the appearance of a separate resonance in the generated second harmonic and sum frequency waves, there is quantitative agreement between theory and experiment for values of ω_p/ω up to about 0.3 ($n \lesssim 10^{11}$/cc), and qualitative agreement for electron densities up to about 10^{12}/cc. The second investigation concerned the measurement of electron elastic collision cross-sections.

GEORGIA INSTITUTE OF TECHNOLOGY, ENGINEERING EXPERIMENT STATION

5354 Technical Report 1, "Acoustic Modulation of the Conductivity of Salt Solutions," W. K. Rivers, Jr., D. F. Eagle, J. R. Walsh, Jr., and D. J. Bryant, Nonr-991(08), 28 Jun 61, (40:16), Unclassified, AD 260 534.

Fractional change in the conductivity of aqueous sodium chloride solutions was measured by observing the modulation of an electromagnetic wave reflected from the water surface, and was found to be 0.7×10^{-10} per dyne/cm^2 pressure change. Acoustic and electromagnetic waves were reflected from the salt water surface in a coaxial test cell at a radio frequency of 146 Mc and acoustic frequencies in the range of 15 to 30 kc. Data taken yield no information on the magnitude of dielectric-constant perturbation relative to conductivity perturbation. Measurements were consistent with theoretical predictions and previous measurements of the change in low-frequency bulk conductivity of salt water produced by an acoustic wave.

GOODYEAR AEROSPACE CORPORATION

5355 Report GERA-463, "Radar Terrain Return Study. Final Report: Measurements of Terrain Back-Scattering Coefficients with an Airborne X-Band Radar," NOas-59-6186-c, 30 Sep 59, (170:1), Unclassified, AD 229 104.

The radar reflectivity of homogeneous terrain was systematically measured at aspect angles from 10° to 65°; some terrain measurements were also taken at aspect angles of 1° to 10°. The calibrated airborne side-looking radar operated at 9375 Mc with horizontal polarization, an azimuth beamwidth of 4°, and pulse-length of 0.78 μsec. A calibrator determined the ratio of received-to-transmitted

GOODYEAR AEROSPACE CORPORATION (CONT.)

5355 (Cont.)

power. Radar strip maps and video data were recorded on film and later read out by a flying spot scanner. Terrain was identified by aerial photography keyed to radar data.

Descriptions and photographs are given for each of the fifteen terrain types studied. Data for each measurement run are included, as well as plots of averaged data for the backscattering coefficient σ^o. The general trend of the data is suggested by the following points selected from these plots.

Backscatter Coefficient σ^o for Fifteen Terrain Types

	σ^o in dB for Various Aspects			
Terrain Type	10°	25°	45°	65°
2' marsh grass (N. J.)	-18	-14	-12	-11
6-40' oak and pine trees (N. J.)	-17	-14	-12	-11
75' mangrove trees (Fla.)	-15	-13	-11	-9
3-6' saw grass (Fla.)	-15	-11	-9	-8
15-40' pine trees (Ariz.)	-19	-15	-13	-10
dry grassland (Ariz.)	-22	-20	-16	-11
6" cotton seedlings (Ariz.)	-20	-12	-10	-8
4' mature cotton (Ariz.)	-16	-11	-9	-8*
1-3' irrigated crops (Ariz.)	-19	-11	-10	-9*
desert, 10-30% vegetation (Ariz.)	-21	-18	-17	-16*
desert sand, 1-2% vegetation (Ariz.)	-30	-28	-23	-12
desert, 10-15% vegetation (Calif.)	-22	-21	-18	-10
desert, sparse vegetation (Calif.)	-24	-19	-13	-9
35' trees (Minn.)	-18	-13	-11	-9
2-3' meadow grass (Minn.)	-19	-15	-14	-10

*Data are for aspect angle 55°

Plotted bands representing 70% of the data show approximate spreads of less than ± 2 dB about the averages given above. Data given on the variation of σ^o between 1° and 10° for the two cotton types and the desert with 10-30% vegetation show that an exceptionally low value of return is reached between 1° and 4° at the bottom of a steep dip. (Ed: A probability-density curve of several thousand data points is given for each terrain type at an aspect angle of about 20°, but the data for this analysis seem to be inconsistent.)

By combining data curves, it is found that σ^o vs. aspect angle divides into fairly distinct bands. The band of "heavy vegetation" is less than about 5 dB wide and about 13 dB higher than that for desert areas. "Sandy desert" gave the lowest data curve, and "broken desert" measurements fell in a narrow band about 5 dB below that of heavy vegetation. For comparison, plotted sea data from Grant and Yaplee (Abstract 8144J) give an upper band limit approximating that of sandy

GOODYEAR AEROSPACE CORPORATION (CONT.)

5355 (Cont.)

desert for sea return with 15-20 knot winds, and a lower band limit about 10 dB less for wind of 0-10 knots.

GÖTTINGEN UNIVERSITÄT, III. PHYSIKALISCHES INSTITUT (GERMANY)

5356 Technical Final Report (RADC-TR-57-185E), "Absorption and Transmission of Electromagnetic Waves. Phase E. Application of Methods of Architectural Acoustics to Electromagnetic Waves," S. Vogel, AF 61(514)-1041, 31 Jul 57, (23:6), Unclassified, AD 131 365.

The absorption coefficient of cm-wave absorbers was determined in two ways: first, from the "reverberation time" of electromagnetic energy in an echo box, which gives a result averaged with respect to the angles of incidence and of polarization, and second, by observing the decrease of stationary energy density when the materials are in a cavity. It was found that the reverberation method was more difficult but permitted more detailed conclusions.

5357 Technical Final Report (RADC-TR-59-26B), "Absorption and Transmission of Electromagnetic Waves. Phase F: Effectiveness of Cm-Wave Absorbers as a Function of Polarisation under Oblique Incidence," K. Walther, AF 61(514)-1041, 31 Jul 58, (58:14), Unclassified, AD 210 938.

Reflection characteristics were studied as a function of incidence angle and polarization for the following absorbers: homogeneous resistive foils, crossed dipoles, homogeneous dissipative layer, and small- and larger-layered thicknesses. The following conclusions were drawn: (1) For layers thin with respect to λ, with optimum matching for both polarizations, the reflection coefficient is below 10% out to an incidence angle of 35°. (2) The maximum incidence angle for 10% reflection can be increased by using larger total thicknesses. (3) If statistically distributed directions of incidence and polarization are considered, sometimes optimum matching of the absorber for both polarization directions yields average reflection factors smaller than optimum matching for only one direction of polarization. Brief comments are made on an absorbing layer with wedge-shaped serrations of the outer face to provide a gradual transition.

Note: Mathematical expressions are frequently illegible in the DDC-supplied reproduction.

5358 Technical (Annual) Report (RADC-TN-59-375B), "Absorption and Transmission of Electromagnetic Waves. Phase B: Development of 3-Dimensional Dipole Absorbers," G. Kurtze and E. G. Neumann, AF 61(052)-154, 30 Sep 59, (72:13), Unclassified, AD 231 020.

Reflection coefficients of dipole absorbers were determined as a function of incidence angle and angle of polarization. With the electric vector parallel to the plane of incidence, an additional system of dipoles normal to the walls was found to reduce reflection considerably at oblique incidence angles; a second minimum of almost zero can be made to occur at 60°. A simplified theory for this consists in replacing the discontinuous current distribution in the layer of normal dipoles by a continuous current flow. Experimental data at 3.2 cm show the variation of reflection with dipole length. A combined absorber showed a reflection coefficient less than 10% for all incidence angles. No way was found to reduce reflection for oblique incident waves having the electric vector normal to the plane of incidence.

GÖTTINGEN UNIVERSITÄT, III. PHYSIKALISCHES INSTITUT (GERMANY) (CONT.)

5359 Technical (Annual) Report (RADC-TN-61-12), "Absorption and Transmission of Electromagnetic Waves. Phase H: Dipole-Resonance-Absorber for Wide Angles of Incidence," E. G. Neumann, AF 61(052)-154, 30 Sep 60, (30:0) Unclassified, AD 250 575.

Program aimed at improving the angular response of dipole absorbers for cm-waves by adding absorbing elements affecting the normal component of the electric field. This is a continuation of previous work (see preceding abstract); much of the original work is included. Emphasis was on the optimum dimensioning of the additional dipole system from theoretical and experimental considerations. It was found that increasing the loss tangent beyond about 0.3 leads to only insignificant reduction of the reflection coefficient for a matching angle of 62.5°. The matching angle shifted towards larger incidence angles with decreasing length and number of dipoles.

5360 Technical (Final) Report (RADC-TR-61-9), "Absorption and Transmission of Electromagnetic Waves. Phase I: Cm-Wave Absorption in Polar Liquids," R. Pottel, AF 61(052)-154, 30 Sep 60, (24:2), Unclassified, AD 250 576.

Absorber materials having high dielectric losses and low dielectric constants were studied experimentally. The complex dielectric constants of ethylene glycol, glycerine, and 1,2-propylene glycol were measured at 10 Gc, then these were mixed with different quantities of gelatine up to nearly the largest possible concentrations at temperatures between 14° and 40° C. A 16% by weight gelatine content reduced attenuation constants of the three liquids by factors of 0.84, 0.73, and 0.81, respectively. Attenuation range was from 6 to 15 dB/cm, and plane-surface reflection coefficients for normal incidence were between 0.36 and 0.49.

5361 Technical (Final) Report (RADC-TDR-62-21), "Absorption and Transmission of Electromagnetic Waves. Phase G: Absorbent Coating on Metal Cylinders," V. Muller, AF 61(052)-154, 30 Sep 61, (48:22), Unclassified, AD 271 790.

Three types were studied experimentally: 377-ohm foil absorbers, $\lambda/4$-layer absorbers, and wedge absorbers, all used for coating circular cylinders with ka = 1 to 10. This case corresponds to the transition region where scatterer dimension is on order of λ. Backscatter from cylinders coated with 377-ohm foil or quarterwave absorbers exceeds reflection from the same absorbers in planar configuration. Wedge absorbers have the most favorable lateral and backscattering properties. These hardly differ from the geometric reflection of plane arrangements at various angles of incidence. Among the three types of absorbers in cylinderical configuration, the wedge has lowest lateral scattering, for equal backscattering. Forward scattering from coated cylinders exceeds that from uncoated cylinders with all three types. Wedges give highly concentrated and more intense forward scatter.

5362 Technical (Final) Report (RADC-TDR-62-22), "Absorption and Transmission of Electromagnetic Waves. Phase H: Dipole-Resonance-Absorber for Wide Angles of Incidence," E. G. Neumann, AF 61(052)-154, 30 Sep 61, (47:16), Unclassified, AD 271 615.

Propagation characteristics were studied for an artificial, absorbing medium consisting of parallel wires with low conductivity. The equivalent complex dielectric constant of the medium was determined using a parallel-plate transmission line with an electric field scanner. Amplitude and phase were measured

GÖTTINGEN UNIVERSITÄT, III. PHYSIKALISCHES INSTITUT (GERMANY) (CONT.)

5362 (Cont.)

and wavelength determined from the variation of attenuation and phase angle. The complex dielectric constant, calculated from the real and imaginary parts of the propagation constant, was used to obtain the characteristic impedance and reflection coefficient of the medium. Curves show attenuation, index of refraction, and reflection coefficient as functions of the wire spacing-to-wavelength (a/λ) ratio. With medium conductivity wires in the sample, the reflection coefficient was about 0.42 from $a/\lambda = 0.35$ to 0.45; 1.0 at 0.5; and decreased to 0.3 at $a/\lambda = 0.7$.

5363 Technical (Annual) Report (RADC-TDR-62-20), "Absorption and Transmission of Electromagnetic Waves. Phase J: Investigation of Interdependence of Absorber Design Parameters," H. W. Helberg, AF 61(052)-154, 30 Sep 61, (37:3), Unclassified, AD 272 110.

The input impedance is derived for a thin homogeneous, dissipative layer in front of a metal plate with and without an air layer. A Ferramic E layer was designed for the frequency interval and for optimal matching (reflection coefficient < 0.10). With a layer thickness of 0.83 cm, effective frequency range was found to be from 44 to 860 Mc with an air layer, and from 30 to 300 Mc without it.

5364 Technical (Annual) Report (RADC-TDR-62-23), "Absorption and Transmission of Electromagnetic Waves. Phase K: Multi-Layer Absorber," H. W. Helberg and C. Wünsche, AF 61(052)-154, 30 Sep 61, (30:10), Unclassified, AD 271 925.

In order to extend the bandwidth, absorber arrangements consisting of two or three layers of homogeneous dissipative material were studied. Frequency-response curves of the derived input impedance and reflection coefficient were calculated for purely dielectric layers. Artificial dielectric and magnetic materials used were realized by mixtures of paraffin and graphite or carbonyl-iron powder, and by foamed-plastic structures containing a regular spatial lattice of damping bodies. A series of curves is given for the loss tangent as a function of graphite and carbonyl-iron concentration. A three-layer absorber was constructed with the following characteristics: $\tan \delta_{\epsilon_1} < 0.01$, $\tan \delta_{\mu_1} = 0.33$; $\tan \delta_{\epsilon_2} = 0.08$, $\tan \delta_{\mu_2} = 0.42$; and $\tan \delta_{\epsilon_3} = 0.78$, $\tan \delta_{\mu_3} = 0.08$. This absorber had a reflection coefficient less than 10% for d/λ between 0.26 and 0.38, and less than 20% for d/λ between 0.22 and about 0.8. In this case d = total length, with $d_1:d_2:d_3 = 1.35:1:1$ and $\lambda = 3.22$ cm in the waveguide.

5365 Technical (Annual) Report (RADC-TDR-62-24), "Absorption and Transmission of Electromagnetic Waves. Phase L: Resonance Absorbers with Absorbing Structures in or Behind a Metal Plate," S. Luhmann, AF 61(052)-154, 30 Sep 61, (38:7), Unclassified, AD 271 797.

The two absorber types described involve absorbing structures behind rather than in front of a metal plate; this plate, effectively an antenna, absorbs incident energy by means of an incorporated dipole lattice in the form of resonant slots (rectangular, triangular, rotational symmetric) and loop absorbers. The resonant slots use a coaxial line absorber; the loops, a strip-line absorber. With circular ring slots, the reflection coefficient was almost independent of polarization direction, and bandwidth was considerably larger than with the loop

5365 (Cont.)

absorber. In one case, the reflection coefficient remained below 15% over a 26% bandwidth at about 11 Gc. About 23 figures indicate the reflection-coefficient frequency responses for various slot sizes. (See also Abstract 5367.)

5366 Technical (Final) Report (RADC-TDR-62-529), "Absorption and Transmission of Electromagnetic Waves. Phase K: Multilayer Absorber," H. W. Helberg and C. Wünsche, AF 61(052)-154, 30 Sep 62, (39:6), Unclassified, AD 288 608.

Design and development of a three-layer absorber are described. Input impedance diagrams were calculated assuming μ and ϵ independent of frequency. By stepwise increasing ϵ and μ from free space to the last layer, the reflection coefficient r remained at best below 13% for $\lambda < 4.75$ cm. Total thickness was $d = 0.21\lambda_{max}$ and the bandwidth for $|r| \leq 10\%$ was 1:2.5. Free-space measurements were made with plates consisting of homogeneous mixtures of paraffin and carbonyl-iron powder, and with regular arrangements of damping cylinders in a loss-free dielectric. The reflection coefficient was obtained over 1- to 6-cm wavelengths for about 20 different combinations of either layer thickness d or dissipative substance. Best performance was obtained with the characteristics: carbonyl-iron powder; $d_1 = 3.0$ mm, $d_2 = 4.0$ mm; $d_3 = 4.5$ mm; $d/\lambda_{max} = 0.252$. In this case the bandwidth ($|r| \leq 10\%$) was 1:2.28 over about $\lambda = 4.5$ to 2 cm. At shorter wavelengths the efficiency of the absorber was limited by the structure of the first layer only (see Abstract 5364).

5367 Technical (Final) Report (RADC-TDR-62-530), "Absorption and Transmission of Electromagnetic Waves. Phase L: Resonance Absorbers with Absorbing Structures in or Behind a Metal Plate," S. Luhmann, AF 61(052)-154, 30 Sep 62, (61:14), Unclassified, AD 288 258.

Continuation of the study described in a preceding abstract (5365) with emphasis on slots in the metal wall rather than loop coupling elements. Rectangular, triangular, and circular ring slots were used as coupling holes. With a wedge absorber behind the metal plate, the reflection coefficient was below 0.1 over a 10% bandwidth at 11.5 Gc; in one case with similar results, the distance spacing between ring centers was 27.5 mm, the outer diameter 14 mm, and the inner diameter 6 mm. With dissipative strip-line components behind the plate, a 6% bandwidth was obtained.

5368 Technical (Annual) Report (RADC-TDR-62-531, Vol. I), "Absorption and Transmission of Electromagnetic Waves. Phase M-Part A: Combination of Magnetic Layer- and Wedge-Type Absorbers," R. Pottel and E. Schunk, AF 61(052)-154, 30 Sep 62, (35:5), Unclassified, AD 288 607.

Initial investigations of an absorption arrangement for electromagnetic waves which incorporated a combination of magnetic-layer absorbers and inhomogeneous absorbers. This arrangement was measured in a waveguide having, in one case, a graphite wedge backed by a ferrite layer which terminates in a metal plate. Reflection coefficients between 25% and 80% were measured with 3000-ohm graphite foil without the ferrite; with the ferrite backing layer, these values were reduced to less than 15% throughout the entire band (0.3-3 Gc). Results of a number of measurements are reported for combinations of ferrite and wedge absorbers.

GÖTTINGEN UNIVERSITÄT, III. PHYSIKALISCHES INSTITUT (GERMANY) (CONT.)

5369 Technical (Annual) Report (RADC-TDR-62-531, Vol. II), "Absorption and Transmission of Electromagnetic Waves. Phase M-Part B: Combination of Magnetic Layer- and Graphite Foil Absorbers," H. W. Helberg and N. Roy, AF 61(052)-154, 30 Sep 62, (23:4), Unclassified, AD 288 653.

The reflection properties of ferrites of different thickness combined with various resistivity foils were measured in a shorted coaxial line. The resistivity foil was used to increase the bandwidth of thick ferrite layers. With a ferrite layer (Ferramic E 1960) 25.8 mm thick and a foil surface resistivity of 880 ohms, the reflection coefficient was less than about 10% from 12 to 160 Mc. Without resistivity foil, the reflection coefficient remained above 10% in the entire range. (See also Abstract 5368.)

5370 AFCRL-TR-60-199, "Low Reflection Absorbers for Electromagnetic Waves," E. Meyer and R. Pottel, Nov 60, (120:36), Unclassified, AD 251 548.

Describes experimental developments of three classes of absorbers: gradual-transition, resonant, and those of homogeneous structure with complex relative permeability (μ) equal to the complex relative dielectric constant (ϵ). Properties examined were dependence of their reflection coefficients on frequency, incidence angle, direction of polarization, and thickness. Absorber types studied were wedge-, pyramid-, and rib-absorbers; foil-, layer-, dipole-, slit-, and loop-absorbers; $\epsilon = \mu$ absorbers; and absorbers with low-density material. About 45 experimental figures present absorber characteristics; measurement techniques and nonreflecting rooms are briefly discussed.

Note: This is a translation by F. Vilbig from a German manuscript for the book Fortschritte der Hochfrequenztechnik edited by Akademische Verlagsgesellschaft, Frankfurt-Main (Germany), 1960.

5371 Final Scientific Report, "Absorption and Transmission of Electromagnetic Wakes. Phase C: Combination of Magnetic Layer- and Graphite Foil Absorbers," N. Roy, AF 61(052)-667, 31 Dec 64, (28:4), Unclassified, AD 466 934.

Analytical and experimental study of a single homogeneous lossy layer in front of a conducting surface. Discussed is the influence of the material on bandwidth and thickness of the absorber. One-layer absorbers with and without shunting resistive foil for a Ni-Zn-ferrite (NZ05, $\mu' \cong 2500$) of different thicknesses were computed and tested. Bandwidths of 10:1 to 15:1 were attained, with the frequency range for a thickness of $d = 3$ cm being between 8 and 112 Mc. The absorption range could be extended by employing two layers of different materials. A Mn-Zn ferrite was inserted between the conducting surface and the input layer of Ni-Zn-ferrite; this manganese-ferrite layer approximates a short-circuit at high frequencies, due to its high dielectric constant. Impedance of the layer increases strongly towards low frequencies.

5372 Final Scientific Report, "Absorption and Transmission of Electromagnetic Waves. Phase D: Combination of Magnetic Layer- and Wedge Type Absorbers," E. Schunk, AF 61(052)-667, 31 Dec 64, (39:8), Unclassified, AD 463 718.

Development of absorbers consisting of thin lossy ferrite layers combined with wedge absorbers. Absorber combinations are effective up to higher frequencies than are pure ferrite-layer absorbers and have smaller total thicknesses than pure wedge absorbers. Inserting an air gap between the ferrite layer and conducting backplate helped in matching the ferrite to the wedge medium. Between 150 Mc and 4 Gc the reflection coefficient remained smaller than 10%; measurements were taken from 50 Mc to 30 Gc. The dependence of reflection on incidence angle was not investigated.

GRUMMAN AIRCRAFT ENGINEERING CORPORATION

5373 Research Report RE-186, "A Study of Radar Probing of the Lunar Subsurface," D. J. Cermignani, Oct 64, (231:89), Unclassified, AD 468 915.

The possibility is considered that useful information may be obtained about the upper strata of the lunar surface with a radar system installed in a lunar orbiting satellite. Information concerning the existence, approximate thickness, dielectric constants, and conductivity of pronounced stratified layers is found to be obtainable from knowledge of reflected-wave amplitude as a function of frequency for CW excitation and from echo returns in the time domain for pulsed operation. However, the ability to extract such data from reflected wave amplitudes is strongly dependent upon the average conductivity. If this value exceeds 10^{-4} mhos/m, it is unlikely that useful information can be obtained. While the average conductivity for "good earth" is of the order of 10^{-2} mhos/m, thermal radiation measurements during lunar eclipses suggest that the average conductivity of the lunar surface is of the order of 10^{-5} mhos/m, which makes the lunar microwave probing scheme quite possible.

More than half the report is given over to four technical appendices: (I) "The Electromagnetic Fields in the Presence of a Smooth Semi-Infinite Medium with Longitudinally Varying Properties" (12 pp); (II) "Reflection Coefficient $\Gamma''(0)$ of a Stratified Moon Model by Scattering Matrix Techniques" (7 pp); (III) "Magnitude of $\Gamma''(0)$ versus Frequency for a 29 Layer Moon Model" (148 pp); and (IV) "Transient Propagation in the Presence of a Homogeneous Moon Model" (6 pp). Appendix III comprises a set of graphs of power reflection coefficient vs. frequency for a stratified model simulating a lunar subsurface having continuously varying dielectric constant and conductivity as a function of depth; several variations are studied.

HARRY DIAMOND LABORATORIES

5374 Report TR-911, "Geometry of Radar Target Location through a Passive Receiver," W. J. Brinks, 24 Mar 61, (16:-), Unclassified, AD 270 705.

This report is concerned with the possibility that emanations from a non-cooperating enemy radar could be picked up at a passive receiving site after reflection from terrain targets and displayed on a PPI. The direct signal from the radar would be used for timing purposes. The geometry of the problem is analyzed for the case of a display centered on the radar and one centered on the passive receiver. No reflectivity data are included.

5375 Report TR-945, "X-Band Radar Cross-Sectional Area Measurements of 81-mm and 105-mm Mortar Shells and 105-mm Artillery Round," F. T. Liss, 25 May 61, (10:1), Unclassified, AD 259 444.

A short-pulse X-band radar (9300 Mc) was used to measure the static cross-sections of 81-mm and 105-mm mortar shells and 105-mm artillery rounds. Return from the test target was noted, and then the return from a standard target was attenuated with a calibrated waveguide attenuator to match; the relative echo area was given directly by the attenuator reading. For viewing angles near the forward direction, the results average roughly as follows: 105-mm mortar shell, 1 ft^2; 81-mm mortar shell, 1/4 ft^2; 105-mm artillery round, 1/4 ft^2.

HARRY DIAMOND LABORATORIES (CONT.)

5376 Report TR-1040, "Relationship Between Specular Reflection Patterns and Reflecting Body Shape," W. J. Brinks, 3 Aug 62, (20:0), Unclassified, AD 283 019.

When electromagnetic radiation is specularly reflected from a body and then allowed to fall upon a surface, it produces upon this surface patterns of curves which are called "traces." The analysis of this report develops the relationship between the form of the traces and the shape of the reflecting surface. The discussion is limited to the optical case, i.e., body dimensions large compared to λ. Examples are shown for a cone and a cylinder. Also considered is the variation of the traces with time as the body rotates.

5377 Report PR-61-10, "Investigation of Satellite-Related Ionospheric Anomalies," F. Vrataric, Oct 61, (49:45), Unclassified, AD 265 849.

Results of an experimental investigation of satellite-related ionospheric anomalies including monitored CW reflected waves and radar backscatter at 20 Mc. It is indicated that non-satellite-related anomalies occur too frequently to enable the identification of satellite ionization effects with any degree of confidence. A method for obtaining transmission signatures is described, and a bibliography of related work is included.

HARVARD UNIVERSITY, BLUE HILL METEOROLOGICAL OBSERVATORY

5378 Meteorological Radar Studies No. 5, "Synoptic-Physical Implications of 1.25 cm Vertical Beam Radar Echoes," R. J. Boucher, AF 19(604)-950, 31 May 57, (24:11), Unclassified, AD 117 220.

Echo types representing several precipitation-growth mechanisms were observed with a 1.25-cm APS-34 vertical-beam radar and were shown to be well correlated to three basically different classes of synoptic situations. A generalized echo-cyclone model was derived. Maximum attainable hourly rates of precipitation were found to be empirically related to the depth of detectable echo. A slight correlation was discovered between the heights of the warm-front surface and the echo top, and a marked increase in the frequency of precipitation echoes occurred within the temperature interval from -11° to -15° C.

5379 Meteorological Radar Studies No. 10 (AFCRC-TN-58-401), "Vertical Structure of Continuous Streamer-form Precipitation," R. Wexler and D. Atlas, AF 19(604)-950 and AF 19(604)-3492, 28 Mar 58, (38:18), Unclassified, AD 152 551.

Observations with a 1.25-cm vertically pointing radar are analyzed for three cases involving snow from closely-spaced generating cells aloft and the resultant snow streamer below. Emphasis is placed upon the synoptic origin and physical structure of these cells and on their relation to radar-reflectivity measurements. Absolute values of reflectivity near the surface are estimated from precipitation intensities by means of the empirical equation $Z = CR^{1.6}$, where R is the precipitation rate in mm/hr and C is a constant that ranges from 500 to 1800 depending on the aggregation of the snow. Precipitation intensities are also computed and compared with reflectivity measurements. The meteorological factors influencing reflectivities at several levels are discussed. Charts of echo-height and reflectivity contours are presented, along with graphs showing average variation of reflectivity-factor Z with height.

HARVARD UNIVERSITY, BLUE HILL METEOROLOGICAL OBSERVATORY (CONT.)

5380 Meteorological Radar Studies No. 11 (AFCRC-TN-58-263), "Radar Observation of Cold Front Thunderstorms of July 14, 1956," C. R. Shackford, AF 19(604)-950, 28 Mar 58, (39:9), Unclassified, AD 152 501.

Describes relationships found between a squall line of intense thunderstorms and echoes observed with a 3.2-cm CPS-9 radar. Orographic features (mountains) were found to be associated with the initial radar echo appearances of the storms. Echo intensification was found to be associated with echo combination, passage of echoes over specific geographic areas, and abrupt course changes. A qualitative relationship was shown to exist between echo intensification and severe weather at the surface. A negative correlation was shown to exist between echo speed and intensity, and a positive correlation between echo speed and height. Also included are several echo-intensity contours and graphs, relating surface rain and hail to echo heights and intensities.

HARVARD UNIVERSITY, CRUFT LABORATORY

5381 Scientific Report 11 (AFCRC-TN-57-591), "Back-Scattering Cross Section of Circular Metallic Cylinders Surrounded by a Resistance Foil," H. J. Schmitt, AF 19(604)-786, 25 Jun 57, (15:3), Unclassified, AD 133 636.

Scattering of a plane wave by a circular metallic cylinder surrounded by a thin resistance foil is investigated for the cases where the electric vector is either parallel or perpendicular to the cylinder axis. The scattered wave is expressed by an eigenfunction expansion, and the resulting coefficients are used to calculate the backscatter cross-section for metallic cylinders of different radii. Results show that the backscatter cross-section of metal cylinders can be decreased by making the surface impedance of the resistive layer equal to the characteristic impedance of the surrounding medium. Experimental results are given to support the analysis.

5382 Scientific Report 13 (AFCRC-TN-57-961), "The Reflection of Electromagnetic Waves from Surfaces of Complex Shape. II. Theoretical Studies," R. King and T. T. Wu, AF 19(604)-786, 20 Dec 57, (83:57), Unclassified, AD 133 780.

Critical discussion of theoretical research related to the reflection of electromagnetic waves from surfaces of complex shape. The nature of a diffracted field is described in detail for the circular conducting cylinder with ka = 3.1. Patterns of radial standing waves superimposed on travelling waves are represented and their relative amplitudes and phases are correlated. Surface currents on circular conducting cylinders are investigated in detail. Relations between amplitudes and phases for large and small cylinders are described and their significance to the qualitative determination of the diffracted field of large cylinders is considered. The determination of high-frequency formulas for the total scattering cross-sections of circular conducting cylinders is reviewed in terms of a rigorously defined creeping-wave structure. Brief mention is made of the backscattering cross-sections of conducting cylinders coated with a layer of dielectric or surrounded by a resistive foil.

The parallel problem of scattering by a conducting sphere is discussed more briefly. Reference is made to the surface currents on spheres as determined from asymptotic formulas for large ka, and their amplitudes and phases are compared with corresponding quantities for the cylinder. The high-frequency formula is given for the total scattering cross-section of the conducting sphere when illuminated by a plane electromagnetic wave. Scattering from strips and disks, and the complementary problems of transmission through slits and apertures are also treated.

HARVARD UNIVERSITY, CRUFT LABORATORY (CONT.)

5383 Scientific Report 15 (AFCRC-TN-58-110), "Electromagnetic Back-Scattering from Thin Circular Disks by a Microwave Pulse Method," C. C-H Tang, AF 19(604)-786, 25 Mar 58, (17:14), Unclassified, AD 146 809.

An experimental investigation concerned with the feasibility of using pulse radar to measure backscatter cross-sections for small obstacles of arbitrary shape at close range. The use of a short pulse allows incident and scattered fields to be separated in time, so that the lower limit of measurement can be extended by raising source power. Various techniques for generating short pulses were considered in these experiments, but the method finally adopted involved using a nanosecond DC pulser to modulate a crystal in a side arm of a hybrid junction (this is a variation on the familiar CW Magic-T method). Base pulse widths of about 40 nanoseconds were achieved. Thin circular metal disks were used as the targets, and the results showed excellent agreement with exact theory. The report includes a summary of the exact solution of scattering from thin circular metal disks, based chiefly on J. Meixner and W. Andrejewski, Ann. der Physik 6, 156-68 (1950).

5384 Scientific Report 16 (AFCRC-TN-58-138), "High-Frequency Diffraction of Electromagnetic Waves by a Circular Aperture in an Infinite Plane Conducting Screen," S. R. Seshadri and T. T. Wu, AF 19(604)-786, 10 Mar 58, (23:6), Unclassified, AD 146 895.

A study on the scattering of plane electromagnetic waves by a circular aperture of radius a in an infinitely conducting plane screen of zero thickness and infinite extent. The first few terms in the asymptotic expansion of the transmission coefficient of a circular aperture in a plane conducting screen are calculated directly from the integral equation without employing any numerical process. In the limit of large ka at normal incidence, the ratio of the transmission cross-section to the geometrical-optics value πa^2, is found up to the order $(ka)^{-5/2}$. The three normalized terms which are obtained by adding respectively one, two, and three correction terms to the geometrical-optics value, along with the exact transmission coefficient, are plotted for the range $0 \leq ka \leq 10$.

5385 Scientific Report 17 (AFCRC-TN-58-161), "High-Frequency Transmission Coefficient of an Infinite Slit in a Plane Screen," S. R. Seshadri, AF 19(604)-786, 20 May 58, (14:5), Unclassified, AD 152 397.

Treatment of the scattering of a plane wave by an infinite slit of width 2a, in a plane, acoustically soft screen of zero thickness and infinite extent. Simultaneous integral equations are obtained for the unknown functions on the shadow side of either screen. Application of complex Fourier transformation to these equations results in two simultaneous algebraic equations which are solved by the Wiener-Hopf procedure. In the limit of large ka and for any angle of incidence other than grazing, the ratio of the transmission cross-section to the geometric-optics value 2a is found, up to order $(ka)^{-5/2}$.

5386 Scientific Report 18 (AFCRC-TN-58-365), "Back-Scattering Cross Section of Reactively Loaded Cylindrical Antennas," B-O Ås and H. J. Schmitt, AF 19(604)-786, 15 Aug 58, (22:9), Unclassified, AD 160 809.

An experimental and theoretical investigation of the broadside backscatter cross-section of reactively loaded dipoles. Theoretical calculations consisted

HARVARD UNIVERSITY, CRUFT LABORATORY (CONT.)

5386 (Cont.)

of a first-order variational solution assuming a dipole model with a discrete "slice impedance" at the center. Bistatic scattering experiments were performed at 2 Gc on a large ground screen using dipoles of different lengths and thicknesses with sections of coaxial transmission line as reactive loads.

The theoretical solution follows closely the work by Tai for the unloaded dipole, assuming that dipole radius a is small compared to length h and $ka \ll 1$. A pole-zero plot of σ/λ^2 for eight kh values ranging from 1 to $5\pi/2$ produced the following conclusions: (1) σ/λ^2 cannot be zero or infinite when the dipole is loaded with a passive impedance; (2) only pure reactances need be considered for minimum σ/λ^2; and (3) for kh values around 2π, σ/λ^2 is less sensitive to kh variations. σ/λ^2 is obtained for the eight kh values, the loading impedance being restricted to reactive loads with emphasis on maximum and minimum σ/λ^2 value.

Measurements of σ/λ^2 for unloaded antennas ($ka = 0.066$) exhibited good agreement with theory for lengths up to around λ. σ/λ^2 was measured as a function of the short-circuit position for eight kh values, and found also to have good agreement with theory. For short antennas, a sharp minimum in σ/λ^2 occurred at $kh = \pi/2$ and the maximum σ/λ^2 value is larger in magnitude than the backscattering cross-section of the unloaded antenna. As kh increases, the magnitude of the minima increases, and for antennas larger than $kh = \pi$ pronounced minima or maxima are no longer observed.

The significant conclusions of this report were: (1) For slim cylindrical objects with $h < \lambda$, σ/λ^2 can be greatly reduced by a suitable reactance load in the center of the antenna. (2) Reduction is possible for longer objects if the object is split into more than two parts and loaded at more than one point, such that no part of the object is longer than $\lambda/2$.

5387 Scientific Report 20 (AFCRC-TN-59-125), "High Frequency Diffraction of Plane Waves by an Infinite Slit," S. R. Seshadri, AF 19(604)-786, 31 Oct 58, (57:6), Unclassified, AD 210 084.

A treatment of scattering of plane electromagnetic waves by an infinite slit of width 2a formed by two perfectly conducting, semi-infinite coplanar screens of zero thickness. For normal incidence with the slit edges parallel to the incident magnetic vector, the asymptotic series for the transmission cross-section per unit of slit length is determined up to the order $(ka)^{-4}$. The diffraction pattern in the far field and the currents on the two screens are also evaluated. The generalization of the method for non-normal incidence is also worked out. Extensive tables of the transmission coefficients per unit slit length are included. In addition, curves giving the value of the second, third, and fourth terms in series expansion for the transmission cross-section per unit length are plotted vs. ka for various angles of incidence and for both E and H polarization.

5388 Scientific Report 23 (AFCRC-TN-59-126), "High Frequency Diffraction of Plane Waves by an Infinite Slit for Grazing Incidence," S. R. Seshadri and T. T. Wu, AF 19(604)-786, 31 Oct 58, (15:2), Unclassified, AD 210 085.

HARVARD UNIVERSITY, CRUFT LABORATORY (CONT.)

5388 (Cont.)

Treatment of scattering of a plane electromagnetic wave at arbitrary grazing incidence by an infinite slit of width 2a formed by two perfectly conducting coplanar screens of zero thickness. The incident wave is polarized with magnetic vector parallel to the slit, so the normal derivative of the wave function vanishes over the surface of the screens. The transmission cross-section per unit length is evaluated in the limit as the angle of incidence approaches $\pi/2$, measured from an axis perpendicular to the screens, and in the limit of large ka. The asymptotic series for the transmission cross section per unit length is evaluated up to the order $(ka)^{-11/2}$, and is plotted vs. ka at grazing incidence.

5389 "Quarterly Scientific Reports," AF 19(604)-786, (3:0), Unclassified.

QSR	Report	Date	AD No.
18	AFCRC-TN-58-109	1 Jan 58	146 808
20	AFCRC-TN-58-364	1 Jul 58	160 808

These short progress reports contain only brief abstracts on the status of work tasks that are described in detail in the Scientific Reports (see preceding abstracts).

5390 Scientific Report 2, Series 2 (AFCRC-TN-59-788), "Theoretical and Experimental Study of the Back-Scattering Cross Section of an Infinite Ribbon," M. S. Macrakis, AF 19(604)-4118, 5 Jun 59, (18:11), Unclassified.

This report concerning the backscatter cross-section per unit length of an infinite ribbon having width 2a is divided into two parts. In the first, the backscatter cross-section per unit length of an infinite ribbon is determined theoretically as a function of ka when the incident wave is polarized parallel to the ribbon edge. The geometrical-optics approximation is applied with the result that $\sigma_B k \cong 1 + (2ka)^2$ for ka > 1.0, where σ_B is the backscatter cross-section per unit length.

Part 2 discusses the experimental measurements which were performed in a parallel-plate medium using a space-separation technique. When compared with the theoretical, the experimental results for ribbons are excellent, but some error was noted in measurements performed on cylinders. The geometrical-optics results obtained in Part 1 are compared with the exact theoretical result, the Sommerfeld approximation, the variational method, and the experimental results. These comparisons are made in the form of curves giving the backscatter cross-section per unit length vs. ka for a normally incident plane wave. Other curves compare the geometrical backscattering cross-section per unit length to the theoretical result for non-normal incidence.

5391 Scientific Report 17, Series 2 (Final Report; AFCRL-63-189), "Research in Electromagnetic Scattering and Antennas. A Summary," R. W. P. King, AF 19(604)-4118, 15 Apr 63, (15:12), Unclassified, AD 425 735.

Brief, qualitative abstracts are presented for research projects described in Scientific Reports 1-15, Series 2.

5392 Scientific Report 7, Series 3 (AFCRL-65-6), "Scattering of Electromagnetic Waves by a Helical Sheath Cylinder," C-L Chen, AF 19(628)-2406, 4 Nov 64, (29:16), Unclassified, AD 612 631.

HARVARD UNIVERSITY, CRUFT LABORATORY (CONT.)

5392 (Cont.)

An investigation of the scattering of electromagnetic waves by a helical sheath, a limiting form of the helix which can be imagined as an infinite number of fine, parallel wires closely wound around a circular cylinder so that the surface is perfectly conducting in the direction of the wires, and nonconducting in the perpendicular direction. For either TE- or TM-mode incidence, the diffracted field contains both TE and TM modes because of the anisotropic boundary conditions. A harmonic-series solution is determined for TE-mode incidence, and expressions found for total scattering cross-section, backscattering cross-section, and current density distribution. Curves show the current density and cross-sections vs. kb (b is cylinder radius) for various values of pitch angle. Unusual behavior as pitch angle approaches $\pi/2$ is discussed.

5393 Scientific Report 8, Series 3 (AFCRL-65-87), "A Diagnostic Theory for Cylindrical Plasmas Based on the Born Approximation," R. D. Ruquist, AF 19(628)-2406, 15 Dec 64, (39:6), Unclassified, AD 612 632.

The inverse scattering problem for a plane, axially polarized, electromagnetic wave incident upon a cylindrically symmetric inhomogeneous medium is solved under the Born approximation. The medium is characterized by a "profile" defined by the inhomogeneous Helmholtz equation. The solution of the inverse scattering problem expresses the profile as a function of the far-field scattering pattern. At certain angles of the pattern its magnitude is directly proportional to the amplitude of the Fourier-Bessel series expansion of the profile.

Based on the solution, a diagnostic technique is suggested for determining the radial inhomogeneities in cylindrical plasmas. It is indicated that this technique is applicable to a range of plasmas including lossy and compressible plasmas immersed in an axial DC magnetic field, and that both the radial variations of plasma frequency and the collision frequency may be determined. Plasma profile determination requires scattering measurements at a relatively small number of angles.

Ed: The author fails to define many of the mathematical symbols he manipulates.

5394 Technical Report 343, "A Theory of Radar Reflections from a Statistically Rough Moon," D. F. Winter, Nonr-1866(32), 5 Jun 61, (17:0), Unclassified, AD 261 980.

The stochastic average of power scattered by a statistically rough moon is derived for both CW and short-pulse transmission. In the latter case, pulse modulation of the incident fields is considered explicitly. A consequence detailed echo shape during the early part of the return is determined. Theoretical results are compared with experimental observations of Trexler and Pettengill.

5395 Technical Report 349, "Scattering by Discontinuities of Surface Waves on a Unidirectionally Conducting Screen," S. R. Seshadri, Nonr-1866(32), 15 Jan 62, (29:5), Unclassified, AD 274 142.

It is shown that surface waves can propagate on a plane screen consisting of separate but closely spaced parallel wires whose radius and spacing are both small compared to a wavelength. Propagation is found to be possible in any direction except parallel to and normal to the wires. The field of the surface wave decays exponentially in the direction normal to the plane of the screen, and becomes more tightly bound to the surface as the angle between the wires and the

HARVARD UNIVERSITY, CRUFT LABORATORY (CONT.)

5395 (Cont.)

direction of propagation approaches $\pi/2$. Radiation from the open end of such a semi-infinite surface waveguide is treated, and the radiation pattern and power-reflection coefficient are obtained. Results are the same as for the case of a junction of the semi-infinite screen and a perfectly conducting half-plane. Also treated is the junction of two such screens whose wires are oriented in different directions.

5396 Technical Report 360, "Diffraction by a Circular Aperture in a Unidirectionally Conducting Screen," S. R. Seshadri and T. T. Wu, Nonr-1866(32), 10 Apr 62, (31:9), Unclassified, AD 275 334.

(RC-8230) Considered is the diffraction of a normally incident plane electromagnetic wave with wave number k by a circular aperture of radius a in a unidirectionally conducting plane screen of zero thickness and infinite extent. In the limit of large ka, the ratio of the transmission cross-section to the geometrical-optics value πa^2 is found up to the order $(ka)^{-3/2}$. A new feature of this problem is that a set of rays in the sense of Keller's geometrical theory of diffraction emanates from the regions of the aperture rim to which the current on the screen is nearly tangential and proceeds in all directions. However, for the case of normal incidence, these rays do not contribute to the transmission cross-section up to the order $(ka)^{-3/2}$.

5397 Technical Report 376, "Diffraction by a Perfectly Conducting Semi-Infinite Screen in an Anisotropic Plasma," S. R. Seshadri and A. K. Rajagopal, Nonr-1866(32), 15 Oct 62, (20:3), Unclassified, AD 291 918.

Study on scattering of a plane electromagnetic wave by a perfectly conducting semi-infinite screen embedded in a homogeneous plasma. Under certain approximations, the plasma is equivalent to a dielectric medium characterized by a tensor dielectric constant when an external magnetic field is present. A perfectly conducting half-plane is embedded in such a medium with its edge parallel to the direction of the external magnetic field. The scattering of a plane electromagnetic wave, incident normally on this half-plane, is investigated. The problem is formulated in terms of an integral equation, which is solved by an application of the Wiener-Hopf procedure. It is found that a new type of impedance boundary condition is satisfied for the E-mode. A surface wave is found to exist for one orientation of the external magnetic field and the characteristics of this surface wave are determined.

5398 Technical Report 380, "Scattering by a Narrow Perfectly Conducting Infinite Strip in a Gyrotropic Medium," S. R. Seshadri, Nonr-1866(32), 25 Oct 62, (11:3), Unclassified, AD 291 752.

The scattering of a plane electromagnetic wave by a perfectly conducting infinite strip of width 2a is investigated for the case in which the surrounding medium is a homogeneous plasma through which a static magnetic field has been impressed. The strip is oriented with its edges parallel to the magnetic field. The problem is formulated in terms of an integral equation whose solution is obtained in the form of a series in powers of ka. Expressions for the far-zone fields and the first two terms in the series for the total scattering cross-section are obtained.

HARVARD UNIVERSITY, CRUFT LABORATORY (CONT.)

5399 Technical Report 402, "Scattering of Unidirectional Surface Waves," S. R. Seshadri, Nonr-1866(32), 15 Feb 63, (20:3), Unclassified, AD 401 894.

A perfectly conducting plane embedded in a gyrotropic medium is shown to be able to support a unidirectional surface wave. Such a surface wave is assumed to be incident on the top of a semi-infinite screen, where the edge of the screen is parallel to the gyrotropic axis of the medium. At the edge, the incident power is converted partly into a reflected surface wave which travels on the bottom of the screen and partly into a space wave. The angular distribution of the radiated energy as well as the power reflection and transmission coefficients are evaluated. Total reflection is shown to occur for a certain band of frequencies.

5400 Technical Report 409, "Scattering by a Perfectly Conducting Cylinder in a Compressible Plasma," S. R. Seshadri, I. L. Morris, and R. J. Mailloux, Nonr-1866(32), 15 Apr 63, (17:3), Unclassified, AD 413 340.

The scattering of a plane electromagnetic (EM) or plasma wave by a perfectly conducting and rigid circular cylinder of radius a immersed in an isotropic, compressible plasma is treated. Expressions in the form of infinite series are obtained for all physical quantities of interest. The total scattering cross-section of both the EM and plasma wave is plotted vs. ka for various ratios of ω_p^2/ω^2, where ω is the frequency of the EM wave, and ω_p is the plasma frequency. The backscattering cross-section for the EM wave is plotted vs. the same parameters, and is shown to oscillate about the value πa. The magnitude of the surface current density is calculated for ka = 3.1 and plotted against the angle of incidence for various values of ω_p^2/ω^2.

HERMES ELECTRONICS COMPANY

5401 Technical Report 1 (DASA-1155), "Addition Theorems for Spherical Wave Functions," S. Stein, Nonr-2632(00), 15 Aug 59, (36:11), Unclassified, AD 229 026.

Addition theorems for spherical vector wave functions (characteristic solutions of the vector wave equation in spherical coordinates) are described under both rotation and translation of the coordinate system. The theorems are based on corresponding theorems for scalar spherical wave functions, which are also reviewed. The paper is purely mathematical.

5402 Technical Report 2 (DASA-1156), "Inclusion of Antenna Patterns in Electromagnetic Scattering Problems (For Spherically Symmetric Scattering Regions)," S. Stein, Nonr-2632(00), 1 Aug 59, (60:11), Unclassified, AD 229 124.

Description of a general formulation for an electromagnetic scattering problem which takes into account the radiating patterns of both receiving and transmitting antennas. The parameter variations of the scattering region were assumed to be spherically symmetric, but no further restrictions were placed upon its nature, i.e., whether it be pure dielectric, lossy dielectric, or metallic. The mathematical treatment is specific to this model, and extensions to other geometries or more complex scattering regions were not explored. Classical spherical-mode wave functions were employed in the representation. Descriptions are included of appropriate representations for fields and antenna patterns, and of the wave-function addition theorems necessary for establishing the formulation.

HRB-SINGER, INC.

5403 Technical Report 180-R-3, "Radio Propagation Study. Interim Engineering Report," E. Herman, M. Rentschler, W. Russell, and B. Dodds, AF 33(616)-5958, 24 Mar 60, (108:50), Unclassified, AD 234 345.

Survey of propagation effects in the atmosphere (to an altitude of 750 km) on radio waves in the frequency range of 30 Mc to 100 Gc. Terrain diffraction and reflection are included. Atmospheric effects are divided into sections on the troposphere, the ionosphere excluding the auroral region, the auroral region of the ionosphere, and meteor trail effects. Under these sections absorption, refraction, scattering, and time variations (including seasonal variations and fading) are considered. Essentially no information on reflectivity or scattering is given except for very brief sections on auroral scatter and meteor scatter.

HUGHES AIRCRAFT COMPANY

5404 Scientific Report 2, "A Note Concerning the Radar Contrast of Airport Runways," F. Richey, AF 19(604)-1708, [1956?], Unclassified.

Note: This report was not obtained.

5405 Technical Memorandum 575, "A Perturbation Method for Diffraction Problems and Its Application to a Pitted Plane Sheet," C. B. Shaw, Jr., AF 33(038)-28634, Mar 58, (60:3), Unclassified, AD 212 662.

A perturbation method is developed for treating diffraction of a general electromagnetic field incident upon a dielectric obstacle which differs only slightly from an obstacle for which an exact solution can be obtained. The general perturbation formula developed is specialized to a nearly ideal case differing from the exact problem only by the presence of a small cavity. As an example, first-order corrections to transmitted and reflected fields are calculated for an arbitrary plane wave incident on a plane dielectric sheet containing a small cavity.

5406 Scientific Report 6 (AFCRC-TN-59-754), "Improvement of Angular Resolution by Means of Interpulse Frequency Modulation," S. S. Shapiro, AF 19(604)-2625, 15 Jun 59, (26:-), Unclassified, AD 228 083.

A method for improving radar target resolution by using interpulse frequency modulation is analyzed. Included are a mathematical model of the method; description of the experimental procedure (which utilized a modified AN/APG-51A airborne fire-control radar); experimental results for target azimuth separations of 0°, 0.5°, 1°, 3°, 4°, and 5° at 50 dB signal-to-noise ratio; and discussion of the experimental results.

5407 "Angle Deception Radar Reflectors," K. C. Kelly, Aug 59, Unclassified.

Note: This report was not obtained.

5408 Technical Memorandum 603, H. K. Epple, AF 33(600)-36192 and AF 33(600)-38229, 15 Jan 60, Unclassified.

Note: No author designated on Volume 1.

HUGHES AIRCRAFT COMPANY (CONT.)

5408 (Cont.)

Vol.	Title	Pages:Refs.	AD No.
1	Missile Target Systems. Parabag Mark III	17:-	239 059
2	Missile Target Systems. Parabomb Mark II	31:-	239 060
3	Missile Target Systems. Balloon and Balloon-Borne	23:0	239 061
4	Missile Target Systems. POGO-HI	32:0	239 062

Four systems are described which were intended to provide synthetic radar and IR targets for use in testing air-to-air Falcon missiles. Much of each report is devoted to detailed instructions for final assembly, inspection, repairs, and packing.

Volume 1. Radar reflectivity for the Parabag Mark III is provided by a 220° spherical canopy 36 ft in diameter and constructed of metalized nylon. X-band cross-section increases from about 500 ft^2 for horizontal aspect to 1200-2200 ft^2 (scintillating) for 45° below the horizontal. Amplitude scintillation increases with angle and, while appreciable, was acceptable for Falcon target requirements.

Volume 2. The Parabomb Mark II has a radar-reflective ring-slot parachute 48 ft in diameter. Near horizontal aspect the X-band cross-section is 600-1400 ft^2, decreases to 150-300 ft^2 at about 10° below horizontal, and then increases to 450-550 ft^2 at an aspect looking upward into the canopy. Amplitude scintillation is so great that this parachute is no longer used as a radar target.

Volume 3. Radar-reflective balloons and balloon-borne beacons and IR flares are described. Balloons with diameters of 31, 39, 45, and 61 ft had radar cross-sections at X-band of 600, 950, 1260, and 2320 ft^2, respectively. Amplitude scintillations of 10 dB are cited for the 31-ft balloon.

Volume 4. POGO-HI is a rocket-deployed target that uses essentially the same spherical-canopy parachute for radar reflectivity as that described in Volume 1 above.

5409 Scientific Report 8 (AFCRL-65-16), "Propagation of Electromagnetic Waves Through Inhomogeneous Slabs," A. T. Villeneuve, AF 19(604)-8386, Oct 64, (35:12), Unclassified. AD 610 838.

An approximation technique is considered for computing transmission and reflection coefficients for plane waves propagating through stratified slabs. The approximation involves mapping the given problem onto a similar, but exactly solvable problem. The approximate solution is then expressed in terms of the solution of the exactly solvable problem. As an illustration of the technique, the reflection and transmission coefficients of a transition layer are computed. Agreement between exact and approximate values of the coefficients is good.

ILLINOIS INSTITUTE OF TECHNOLOGY, IIT RESEARCH INSTITUTE

5410 "Investigation of the Electromagnetic Properties of Garnet Single Crystals," AF 33(615)-1540, Unclassified.

Quarterly Progress Report 1	June 1964
Quarterly Progress Report 2	September 1964
Quarterly Progress Report 3	December 1964

Note: These reports were not obtained.

ILLINOIS STATE WATER SURVEY

5411 Final Report (AFCRC-TR-58-246), "Evaluation of the AN/APQ-39(XA-3) Cloud Detector Radar," K. E. Wilk, AF 19(604)-1395, 31 Mar 58, (39:10), Unclassified, AD 152 596.

Cloud data was collected in the Midwest during the winter months, using a 0.86-cm radar modified to use separate, vertically pointing, transmitter and receiver antennas. Comparison of theoretical and empirical detection capabilities shows this radar to be an excellent indicator of cloud distributions and of vertical moisture distributions. It has demonstrated the ability to detect 87% of low clouds, 75% of middle clouds, and 54% of high clouds, which compares favorably with a 1.25-cm radar used in another investigation, for which the percentages were found to be 55, 52, and 28, respectively. It is suggested that echo characteristics are generally analogous to cloud type, and hence permit good reliability for interpreting data. The radar was found to be extremely sensitive when detecting surface precipitation; the effect of rain attenuation on cloud return became noticeable when the rainfall rate exceeded approximately 5 mm/h. Numerous figures, PPI photographs, and tables are included.

5412 Scientific Report 1 (AFCRL-TN-61-202), "Radar Investigations of Illinois Hailstorms," K. E. Wilk, AF 19(604)-4940, 15 Jan 61, (42:9), Unclassified, AD 252 198.

This report deals with the use of radar in detecting and identifying severe thunderstorms. An introductory discussion of previous research on severe weather echoes notes that convergence, rapid development, attenuation notches, and lack of a bright band are characteristic indicators of storm severity.

Surface observations of hail are compared with echo-intensity measurements at various altitudes. Data from severe local storm observations was compared with radar data in analyses making use of two independent procedures. Case studies were first made of specific radar echoes known to be associated with severe weather; then, all echoes occurring within designated grid squares in a selected area were studied to determine echo frequencies at various intensity and height levels. Examination of the data leads to the following conclusions: (1) probably the most important criterion for identifying hail-producing thunderstorms in the Midwest is the occurrence of a reflectivity factor Z greater than $10^5 mm^6 m^{-3}$ between 20,000 and 25,000 ft; (2) the maximum Z value appears to occur a few minutes before, and slightly upstream of, the surface hail observations; and (3) precipitation attenuation can seriously restrict the utility of a single radar in examining hailstorms which cover a large geographical area.

5413 "Investigation of the Quantitative Determination of Point and Areal Precipitation by Radar Echo Measurements," E. A. Mueller, G. E. Stout, W. C. Ackermann, et al., DA 36-039 AMC-87280, Unclassified.

Technical Report	Date	Pages:Refs.	AD No.
First Quarterly	not obtained		
Second Quarterly	31 Mar 62	33:3	278 668
Third Quarterly	30 Jun 62	17:0	285 177
Fourth Quarterly	30 Sep 62	13:0	293 250
Fifth Quarterly	31 Dec 62	19:0	299 066
Sixth Quarterly	31 Mar 63	21:3	406 843
Seventh Quarterly	30 Jun 63	10:2	416 149*

*Also catalogued by DDC as AD 419 507.

ILLINOIS STATE WATER SURVEY (CONT.)

5413 (Cont.)

Technical Report	Date	Pages:Refs.	AD No.
Eighth Quarterly	30 Sep 63	24:0	430 614
Ninth	31 Mar 64	49:5	602 744
Final	30 Sep 64	55:11	615 772

This program was concerned with an attempt at correlating radar variables and actual rainfall quantities by means of raindrop-size distributions. Most of the material pertinent to radar reflectivity is contained in the Ninth Technical Report and the Final Report. Earlier reports primarily deal with the collection and analysis of raindrop camera data, the development of computer programs to determine the collision efficiencies of electrically charged raindrops, coalescence curve-fitting techniques associated with drop-size distributions, and the effects of evaporation on drop-size distributions.

In the Ninth Technical Report, three methods are adopted for determining the best estimate of the rainfall rate R for a particular value of radar reflectivity Z. These consist of the standard logarithmic least squares with R dependent, the average value of R for each 1 dB interval of Z, and R obtained from minimizing $\sum_i R_i |R_i - R^*|$, where R^* is the estimate and the R_i are observed points. Values of R for each Z interval are tabulated for the latter two methods.

From a study of rainfall attenuation it is found that the best value of R, given Z and the attenuation cross-section Q, is

$$R = \frac{1.11\, Q^{0.89}}{Z^{0.097}} ,$$

based on logarithmic multiple regression analysis. The multiple-correlation coefficient for these data was 0.97. From the same data a regression of Q on R was obtained as $Q = 2.45\, R^{1.2}$ with the correlation coefficient of 0.97. A logarithmic regression of Z and Q yielded $Q = 1.15 \times 10^{-2}\, Z^{0.91}$ with a correlation coefficient of 0.98. It is concluded that there is no statistical justification for measuring both attenuation and reflectivity to estimate rainfall rate. The actual radar reflectivities used in this study were measured with 3-cm CPS-9, 3.3-cm TPS-10, and 3-cm M-33 radars. The Ninth Technical Report also contains a proposed method of compensating for attenuation and a study of the liquid content of rain.

In the Final Report, a comparison is made of average drop-size spectra obtained from raindrop cameras in a number of locations. Radar observations were made with the same three X-band radars: CPS-9, TPS-10, and M-33. Two methods were adopted to analyze drop-size data obtained from locations in Florida, Oregon, and the Marshall Islands. The first consisted of finding the best least squares linear relationship between the logarithms of R and Z; the second consisted of tabulating the maximum, minimum, and average rainfall rates for each 1 dB interval in Z. Based on these analyses, it is suggested that the rainfall measurement by radar will have an ultimate accuracy of about 20% of total storm rainfall.

Note: A symposium paper is reprinted as an appendix (see Abstract 8671J).

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, DEPARTMENT OF METEOROLOGY (GREAT BRITAIN)

5414 Technical (Scientific) Note 1 (AFCRC-TN-59-477), "Calibration of a Weather Radar Using a Standard Target," D. Atlas and S. C. Mossop, AF 61(052)-254, Sep 59, (17:6), Unclassified, AD 231 806.

Description of how a balloon-borne aluminum sphere may serve as a reference target to calibrate target-echo strength on a weather radar. The sphere is tracked and its echo "measured" by reducing receiver gain control to the threshold of visibility. The resulting calibration on gain setting can be used to determine storm reflectivity.

5415 Technical (Scientific) Note 2, "Radar Scatter by Large Hail," D. Atlas, W. G. Harper, F. H. Ludlam, and W. C. Macklin, AF 61(052)-254, Jan 60, (36:11), Unclassified, AD 242 858.

Radars with wavelengths of 3.3 and 4.67 cm were used to observe the variation in backscatter cross-section of individual artificial hailstones as melting occurs. Plexiglass spheres were used as controls since the index of refraction of plexiglass is close to that of ice. Results of measurements and computations confirm the theoretical cross-sections. An ice sphere was found to be a better scatterer than a liquid-water sphere of equal size when its diameter exceeds 0.8 wavelengths; for diameters between 1.2λ and 2.3λ, an ice sphere is better by a factor of 10 or more.

A detailed discussion of the decrease in cross-section as melting occurs is followed by a treatment of possible causes. It is suggested that the larger cross-section of ice is probably due to the combined effects of inner focusing and reflection by the ice and the relatively high absorption coefficient of water (compared to that of ice). It appears that the reflection from a water sphere is essentially from the front surface, whereas that from an ice sphere is essentially from the back surface. It is noted that by tapering the refractive index with radial distance r in a sphere according to the law $m = [2 - (r/R)^2]^{\frac{1}{2}}$, where R is the radius of the lens, a plane wave incident on the front surface is brought to a perfect focus on the back surface where it may be reflected. A comparison of an ice sphere with a Luneburg lens indicates that an ice sphere with a diameter of 3 inches has a cross-section of 270 cm^2 at a wavelength of 3.3 cm.

5416 Technical (Scientific) Note 3 (AFCRC-TN-60-424), "The Role of Radar in Rainstorm Forecasting," F. H. Ludlam, AF 61(052)-254, Apr 60, (29:6), Unclassified, AD 243 477.

A brief review of the meteorological problems of rainstorm forecasting, and of the essential part played by radar in providing basic data. The relations between intensity and maximum height of echoes, precipitation rate, hail size, and lightning-discharge frequency are estimated. Radar and sferic data requirements, reduction and presentation are considered for the purposes of short-period (1-3 hour) and long-period (6-24 hour) rainfall forecasting. A provisional numerical code (0-9) for echo intensity and maximum echo height is tabulated with associated surface-rainfall rate, hail size, and lightning-discharge frequency. Echo-intensity maps using this code are shown for a severe storm, with corresponding weather charts and 10-cm radar PPI displays.

5417 Technical (Scientific) Note 4 (AFCRC-TN-60-425), "Multi-Wavelength Radar Reflectivity of Hailstorms," D. Atlas and F. Ludlam, AF 61(052)-254, May 60, (95:29), Unclassified, AD 243 478.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, DEPARTMENT OF METEOROLOGY (CONT.)

5417 (Cont.)

Analysis of the prominent reflectivity characteristics of hailstorms at wavelengths of 1.8, 3.3, 4.67, 5.6, and 10 cm. Reflectivities were computed for storms containing hail either in uniform size or in an exponential distribution of sizes, and for both wet and dry hail. Factors considered include attenuation by dry hail, the effects of size sorting by wind shear, particle size, and size spectrum.

It is shown that the variation of reflectivity with wavelength depends on the size distribution of the hail as well as on whether it is wet or dry. Thus it is suggested that multiple-wavelength reflectivity measurements constitute a powerful means of identifying the types of particles and their probable size spectrum. There is no difficulty in distinguishing hail from rain, since the latter shows practically no reflectivity variation with wavelength. It is noted that in regions of uniform hail size, a unique determination of size is permitted by measurement of relative reflectivities at just three wavelengths; the reflectivity magnitude is then a measure of concentration.

It was found that wetting, melting, and size sorting by wind shear cannot account for appreciable reductions in reflectivity below the 0°C level at wavelengths below about 5 cm. Since it is unlikely that large hail can appear wet at longer wavelengths, it is concluded that such reductions are improbable at any wavelength, even under intense melting conditions.

The theoretical discussion is supplemented by observational data on reflectivity measurements at 3.3-, 4.67-, and 10-cm wavelengths and associated hail sizes at the ground during a severe storm near Wokingham, England, and on vertical-reflectivity profiles at 3.2 cm for New England hailstorms. The observed wavelength dependence of maximum reflectivity aloft in the Wokingham storm was found to be consistent only with a very narrow size distribution, and only with hail of specific size. Although the sizes deduced from the radar data are in accord with the sizes observed at the ground, the number concentrations implied aloft by the high reflectivities were found to exceed those at the surface by 10 to 100.

5418 Technical (Scientific) Note 5 (AFCRC-TN-60-426), "Radar Analysis of a Hailstorm," K. A. Browning and F. H. Ludlam, AF 61(052)-254, Jul 60, (105:28), Unclassified, AD 247 287.

Observations of a summer hailstorm in England were made with five radars (two 3.3-cm RHI radars, one 4.7-cm PPI radar, one 10-cm PPI radar, and a 10-cm RHI radar). Radar and routine synoptic data, along with data from special pilot balloon soundings, reconnaissance flights, and about 1500 ground observers, is presented in the form of numerous detailed PPI- and RHI-scope photographs, weather charts, figures, and tables. Several striking features of the storm are noted. The echo mass of the storm is discussed, using maps of intensity contours drawn from PPI photographs taken at different gain settings. In the intense phase of the storm, when 2-inch hailstones fell, the radar echoes persistently showed some features from which the pattern of the air flow in the storm can be deduced; this pattern is discussed in detail and conditions favorable to the growth of large hailstones are delineated. A dynamic model of the storm is constructed with characteristics which are found to be typical of other severe hailstorms.

5419 Technical (Scientific) Note 13 (AFCRL-64-249), "The Distortion of Cumulonimbus Precipitation Observed by Radar," J. R. Probert-Jones, AF 61(052)-254, Nov 63, (21:12), Unclassified, AD 434 779.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, DEPARTMENT OF METEOROLOGY (CONT.)

5419 (Cont.)

When a distributed target such as a cloud is examined by a radar, the finite width of the antenna beam acts to distort the observed pattern by blurring its contours. This report examines this phenomenon, using as an example the beam pattern of the MPS-4 4.67-cm radar applied to two models of cumulonimbus storms. Displayed intensities are presented graphically so that distortions may be examined, both those to the edges of the displayed echo, and those to the intensity pattern. Graphs of the displayed and the actual intensity contours are included for 40-, 100-, and 250-km ranges. The distortion in azimuth and elevation is considerable, especially at great ranges, giving apparent echo tops as high as several kilometers above the true precipitation top. It is noted that an approximation to the true intensities can be recovered from the displayed contours. A nomogram which can be used to correct for the true cloud top is described in detail in an appendix.

INSTITUTE FOR DEFENSE ANALYSES

5420 Research Paper P-7 (IDA/HQ 63-1247; Series B), "The ARPA Reentry Physics Program. Some Problems of Interest," J. J. Martin, SD-50, May 63 [also shown as Feb 63], (25:16), Unclassified, AD 416 041.

This paper deals with broad, general problems in the re-entry physics of ballistic missiles. Problems discussed include fluid mechanics, chemistry, and physics which give rise to radar- and optical-observable phenomena possibly relating to body size, weight, and shape. The general problem of radar backscatter from ionized turbulent flow-fields is also mentioned.

5421 Research Paper P-55 (IDA/HQ 63-2024; Series C), "Backscatter of Electromagnetic Radiation from a Turbulent Plasma," E. E. Salpeter and S. B. Treiman, SD-50, Dec 63, (40:5), Unclassified, AD 433 907.

A semi-quantitative description of scattering of electromagnetic radiation from a turbulent plasma medium. Approximation schemes appropriate for each regime are described and assessed. For a sufficiently underdense plasma, a natural first estimate is represented by the Born approximation for scattering from turbulent eddies. In this approximation, scattering is a volume effect, independent of geometry; but limits on the validity of the Born approximation, and the nature of the next-order corrections, are determined by geometry, multiple scattering, and other effects which are discussed at length. At the opposite extreme, for a sufficiently overdense plasma, scattering is produced by surface fluctuations. Only backscattering is considered, and collision damping is ignored. Particular attention is devoted to the dependence of backscatter cross-section on the incidence angle of the radar beam with respect to the surface of the plasma medium.

Note: This paper modifies and extends an IDA Jason Division paper, "Scattering of Electromagnetic Radiation from a Turbulent Plasma," published as a draft and dated 29 Aug 1962.

5422 Research Paper P-156 (IDA/HQ 64-3076), "The Doppler Radar Spectrum of an Accelerating Target," J. Menkes, SD-50, Dec 64, (14:-), Unclassified.

(BD-7960) Study of the Doppler spectrum of a simple target moving with a constant acceleration. Behavior of the spectrum as a function of observation time and magnitude of the acceleration is deduced in closed form. It is found that the width of the spectrum is proportional to the square root of the number of quarter wavelengths that the target travels due to its acceleration. Results are presented in graphical form.

INSTITUTE FOR DEFENSE ANALYSES (CONT.)

5423 Research Paper P-180 (IDA/HQ 63-1510; Series C), "Multiple Scattering in Arrays of Small Objects," S. Weinberg, SD-50, 3 Aug 60 [reprinted 15 Apr 65], (18:0), Unclassified, AD 464 695.

Scattering and diffraction characteristics of arrays of small objects are calculated, assuming individual members of the arrays to be small, and to scatter isotropically. Treatment is limited to waves that are scalar outside the scatterers so that the wave function obeys the general wave equation $(\nabla^2 + k^2)\,\psi(\vec{r}) = 0$. The power absorbed by each scatterer is calculated, as is the scattering cross-section. Extreme cases and reciprocity are also discussed.

INSTRUMENT ENGINEERING RESEARCH

5424 "Turbulence Measurements at High Altitudes," DA 36-039 SC-78129, Unclassified.

Report	Title	Date	Pages:Refs.	AD No.
Quarterly 1	Two Target Systems	30 Sep 58	34:2	207 938
Quarterly 2	Experimental Investigation of the Two Target System	31 Dec 58	95:-	214 434
Quarterly 3	Theory of Many Target SDI Systems	30 Apr 59	34:2	220 561
Final		30 Sep 59	87:1	232 915

Note: Authors: Reports 1 and 2, S. Lees and D. W. Batteau; Report 3 and Final, S. Lees.

Description of research on a suggested technique for measuring turbulence and wind shear at high altitude by means of modulation produced by interference of radar signals reflected from, or transmitted by, two or more balloon-borne targets. The technique is termed "second difference interferometry." The theory is developed mathematically, first for the case of two targets, and then extended for a many-target system. It is shown that the Cartesian coordinates of the separation vector for two targets can be derived by measuring the phase relationships of interference modulation at each of four receivers in an array. An expression is developed for wind shear, based on measurement of modulation zero-crossing times for the case of passive reflecting targets. Results of two experiments with passive and active targets showed that the signal-to-noise ratios permit extraction of desired information, and that data reduction is practical for a two-target system but not for a multi-target system. Essentially all the material of the quarterlies is covered in the Final Report.

ISTITUTO UNIVERSITARIO NAVALE (ITALY)

5425 Annual Technical Note 1 (RADC-TN-59-195), "Theoretical Research on Microwave Reflecting Surfaces," G. Latmiral, AF 61(052)-36, 28 Feb 59, (16:5), Unclassified, AD 216 896.

Reflection characteristics were theoretically investigated for two absorbers, one non-uniform and the other a resonant absorber composed of two dielectric quarter-wave layers separated by an ohmic film. The resonant absorber was investigated at oblique incidence and found to have a $\pm$ 20% bandwidth (at 98% absorption) when the ohmic film is $0.35\lambda_o$ at a frequency of 21,850 Mc.

ISTITUTO UNIVERSITARIO NAVALE (ITALY) (CONT.)

5426 Annual Technical Note 2 (RADC-TN-61-142), "Nonuniform Transmission Lines and Broadband Microwave Absorbers," G. Latmiral and R. Vinciguerra, AF 61(052)-36, 28 Feb 61, (40:6), Unclassified, AD 260 537.

A theoretical analysis of an inhomogeneous absorber using the separated Riccati differential equation of inhomogeneous transmission-line theory. Solutions are obtained for several cases; a typical result yielded 3.7% reflectivity for a thickness of $\lambda/6$ and a front-surface dielectric constant of 1.5. A brief description is included of experimental measurements carried out on an AN 73 Eccosorb absorber to test the technique.

Ed: Although the authors' command of English is adequate, the non-mathematical text is somewhat difficult to follow.

5427 [Annual] Technical Note 3 (RADC-TN-61-190), "Radar Corner Reflectors for Linear and Circular Polarization," G. Latmiral and A. Sposito, AF 61(052)-36, 15 Jul 61, (28:6), Unclassified, AD 263 179.

Polarization reversal and conversion of radar waves reflected from planar, diplane, and corner reflectors can be achieved by placing wire grids in front of them. For the plane reflector, agreement between theoretical and experimental data is good, but for diplane and in particular corner reflectors, experimental and theoretical results are less compatible. The principles discussed can be used to design reflectors which will be visible to radars using circular polarization.

Note: This article is a modified reprint from the Annals of the Istituto Universitario Navale (Naples) 29, 1960.

5428 Summary Report (RADC-TDR-63-141), "Matching and Absorbing Materials for Microwave Radiation," G. Latmiral, G. Franceschetti, and R. Vinciguerra, AF 61(052)-589, 28 Feb 63, (42:12), Unclassified, AD 299 720.

Earlier work (see previous abstracts) is continued with both theoretical and experimental studies. Since it is difficult to realize a medium whose material properties vary with depth, the possibility was considered of achieving the same result with absorbing surfaces composed of many sharp cones having dimensions small compared to λ, supported by a thin plate of the same material. The reflection spectrum of such tapered-cone absorbers was calculated by numerical solution of the Riccati equation. Power reflections less than 5% were obtained, assuming material properties equal to those of available absorbers, for wavelengths up to 10 times the overall thickness. Waveguide and free-space measurements were made on both stratified and tapered artificial dielectrics composed of metal or graphite powder in a wax medium. A short appendix considers the possibility that the monostatic cross-section of a target can be reduced by increasing the fraction of incident energy that is scattered in other directions.

5429 Technical Note 2 (RADC-TDR-63-315), "Step Approximation of a Tapered Matching or Absorbing Junction," G. Franceschetti, AF 61(052)-589, 31 May 63, (47:10), Unclassified, AD 409 588.

In this theoretical investigation into approximating a tapered absorber junction by a number of homogeneous layers, it is shown that the layered junction acts like a band-pass filter and the tapered like a high-pass filter. Numerical examples accompany a procedure for optimum selection of the layers. In the appendix, a synthesis for the tapered junctions is described along with corresponding analog computer programs. Included in the report is a 6-page reprint of an

ISTITUTO UNIVERSITARIO NAVALE (ITALY) (CONT.)

5429 (Cont.)

article by the author ("The Inhomogeneous Line, or Layer, as a Matching Device," Alta Frequenza 31, No. 11, (1962)), in which the scattering matrix of an inhomogeneous layer is deduced and the reflection coefficient calculated on an analog computer.

5430 Technical Note 3 (IUN Report 1-EM Group), "Scattering from Plane Inhomogeneous Layers," G. Franceschetti, AF 61(052)-589, 15 Sep 63, (38:11), Unclassified, AD 602 463.

Scattering from plane, infinite inhomogeneous layers having arbitrary termination is studied for normal or oblique and real or complex incidence. It is shown that the problem can always be solved via a Riccati differential equation. Approximate solutions are found for two limiting cases (slowly varying media and quasi-static case).

5431 Annual Summary Report 2 (ASR-4), "Matching and Absorbing E.M. Materials," G. Latmiral, G. Franceschetti, and R. Vinciguerra, AF 61(052)-589, 20 Feb 64, (16:9), Unclassified, AD 602 472.

Summary of work performed between February 1963 and February 1964, including a qualitative discussion on stratified layers, artificial dielectric materials, and conical absorbers.

JOHNS HOPKINS UNIVERSITY, APPLIED PHYSICS LABORATORY

5432 Report BPD64U-10, "Ship Cross Sections," J. A. Lieske, 27 Apr 64, (37:1), Unclassified.

This report is a recapitulation of a portion of the results in NRL Memorandum Report 1368 (Abstract 5582), and presents graphs of X-band cross-section vs. elevation angle for various aspects of a YAGR picket ship and a tanker. Data are more easily interpreted as presented in this report, but the earlier report discusses the program in considerably more detail and should be referred to also.

JOHNS HOPKINS UNIVERSITY, CARLYLE BARTON LABORATORY

5433 Technical Report AF-63, "Cross Sections of Large Cylinders by the Variational Method," E. S. Cassedy, AF 33(616)-3374, Mar 59, (143:42), Unclassified, AD 213 561.

The variational technique was applied to scattering from a conducting spheroid or cylinder. The problem was formulated using Green's Theorem in each of two semi-infinite half spaces defined by a plane through the body at the shadow line. The trial function used was the physical-optics approximation for induced currents. Conclusions found are: (1) The half-space formulation using Green's Theorem yields the shadow beam, in addition to the optical reflected ray. (2) Additional fine detail of information, such as "creeping-wave" interference patterns, are not available with this method. (3) No way is known for predicting the accuracy of variational computations in scattering problems when the body is large compared to wavelength. (4) Any attempt to use a higher order of approximation would so complicate the computation as to negate any advantages of simplicity which the method might have had over other methods.

JOHNS HOPKINS UNIVERSITY, CARLYLE BARTON LABORATORY (CONT.)

5434 Technical Report AF-81, "Electromagnetic Cross Sections of Cylinders of Finite Conductivity," E. S. Cassedy and J. Fainberg, AF 33(616)-6753, Aug 60, (20:18), Unclassified, AD 242 395.

Report of work done on the computation of scattering from cylinders of finite conductivity. This method of computing the scattering, based on the variational method, takes into account losses due to conductivity. The main section is a reprint of a journal article (see Abstract 7476J). In this section, the solution of the boundary-value problem by the variational method is described and results are given in terms of backscattering cross-sections. Results of computations are verified against experiment for cylinders assumed to be thin and having a length $< 1\lambda$.

In Appendix A is discussed the validity of results for cylinder lengths greater than λ. It is shown that expressions developed in the main section may be used for cylinder lengths up to 2λ except in a small range of lengths near 1.5λ. Appendix B is a reprint of another journal article (see Abstract 7590J). The expression for the scattered amplitude, taking loss into account, is applied to the case of the total cross-section. Results are cross-checked with calculations based on backscattering results obtained from experiment.

Since resistance tends to reduce both total and backscattering cross-section, despite the fact that absorbed energy is included in the total cross-section, it is concluded that losses are detrimental in both cases mentioned above. The net effect seems to be that the damping of the induced currents due to resistance reduces scattered energy more than it increases energy removed from the wave due to absorption. This effect is, of course, greatest near resonance and is required in the limit where resistance prevents all currents from flowing. Finally, it is pointed out that this method is not restricted to cylinders of circular symmetry, the skin impedance of a conductor of any geometrical cross-section may be calculated in principle.

5435 Technical Report AF-89, "Radiation and Scattering by Cold, Finite Beams," M. J. Scotto and P. Parzen, AF 33(616)-6753, Oct 61, (51:7), Unclassified, AD 266 549.

Two problems are treated which involve scattering by electron beams and plasmas. The first is concerned with the scattering of cylindrical and plane waves by a cylindrical plasma. Scattered amplitudes are computed for zero and infinite confining magnetic fields, and the effect of a finite field is estimated by comparing results for these two extremes. The second problem involves scattering of plane waves by an electron sheet; here, scattered amplitudes are computed for an infinitely thin sheet confined by a magnetic field of arbitrary magnitude.

KATZIN, MARTIN

5436 Final Report, "Sea Clutter at Large Depression Angles," M. Katzin, Nonr-2138(00), [1959], (22:-), Unclassified, AD 225 599 (DDC reference only).

(DDC) A quantitative treatment of sea clutter at large depression angles, based on small rectangular facets of the sea surface as the scattering elements. The facets are assumed to have a bivariate slope distribution given by a Gram-Charlier series. Two models are considered for the orientation of facet edges for a given slope. For a random orientation of edges, a formal solution is obtained for σ° in the form of an infinite series. This solution requires that a computational program be carried out in order to obtain the dependence of σ°

KATZIN, MARTIN (CONT.)

5436 (Cont.)

on the parameters. For facet edges aligned with the wind, an analytical solution is obtained from which the dependence of σ° on frequency, wind speed, and angle is deduced. It is found that the frequency dependence at large depression angles is essentially the same as at small angles up to a high-frequency limit, above which σ° is substantially constant. At vertical incidence σ° is essentially inversely proportional to wind speed. The decrease of σ° with decreasing depression angle in the vicinity of vertical incidence is approximately Gaussian, the exponent being inversely proportional to wind speed.

KIRUNA GEOPHYSICAL OBSERVATORY (SWEDEN)

5437 Scientific Report 4 (AFCRL-726), "Fading Rate of Auroral Reflections at 92.8 Mc/s," A. Egeland, AF 61(052)-418, 25 Apr 61, (26:17), Unclassified, AD 263 900.

Results are summarized of experimental observations of the fading rate of signals propagated via oblique reflection from the aurora. The auroral fading records showed a Rayleigh amplitude distribution, indicating the echoes consisted of a large number of scattered wavelets, and no major specularly reflected portion of the signal was received. Fading frequencies up to 300 or 400 cps were found, but the power in the range 1-100 cps was clearly dominant. The rms value for the random velocity of the auroral irregularities, calculated from the autocorrelation of the amplitude, varied between 100 and 220 m/s.

5438 Scientific Report 5 (AFCRL-62-114), "Polarization Characteristics of Auroral Echoes at 88.5 Mc/s," A. Egeland, AF 61(052)-418, 10 Oct 61, (18:11), Unclassified, AD 604 372.

Reports on an experimental investigation of the polarization characteristics of 88.5-Mc signals reflected from the aurora. The transmitter was a Swedish FM station at Vännäs and the receiver was at Kiruna, Sweden. Observations and data presented show that aurorally propagated waves do not always maintain the plane of polarization after reflection, but rather tend to be randomly polarized. Mechanisms causing depolarization are discussed.

5439 Scientific Report 8 (AFCRL-62-117), "A Study of the Statistics of VHF Oblique Auroral Reflections," A. Egeland, J. Ortner, and B. Hultqvist, AF 61(052)-418, 20 Oct 61, (35:28), Unclassified, AD 274 738.

A statistical study was made of diurnal and seasonal variations in auroral echo activity at 92.8 Mc using data obtained by monitoring an FM signal continuously over a two-year period from the Kiruna (Sweden) Geophysical Observatory. Other investigations of variations are included which are based on ten years of observations. In these, diurnal, day-to-day, and seasonal variations were studied, and the correlation with solar and magnetic disturbances and with visual auroral displays were examined.

LIBRARY OF CONGRESS, AEROSPACE TECHNOLOGY DIVISION

5440 Report 60-112, "Kabanov's Effect," 22 Dec 60, (12:14), Unclassified, AD 250 078.

The chronology and extent of Soviet work on radar backscatter from the ground after reflection from the ionosphere (especially as a means of long-range missile detection) is briefly examined on the basis of unclassified Soviet

LIBRARY OF CONGRESS, AEROSPACE TECHNOLOGY DIVISION (CONT.)

5440 (Cont.)

publications. Evidence suggests that they recognized the importance of the phenomenon rather early and have pursued it vigorously. No technical details are discussed.

5441 Report 61-78, "Reflection of Electromagnetic Waves from the Sun, Moon, and Planets," 19 May 61, (7:9), Unclassified, AD 257 933.

Collection of translated abstracts of technical papers concerning radio astronomy which appeared in the Russian literature during 1958 and 1959. Despite the title, only one deals with reflection of signals from astronomical bodies; it is available in cover-to-cover translation (see Abstract 8274J). One other paper abstracted deals with radar reflection from auroras (see Abstract 7532J).

5442 Report S-63-17, "Book Review of Radar Methods of Meteor Observation," V. V. Fedynskiy, B. Y. Levin, and E. K. Nemirova (reviewers), 23 Jan 63, (3:-), Unclassified, AD 294 996.

A very brief review of a Russian book (Radiolokatsionnyye metody nablyudeniya meteorov, Y. I. Fialko, 111 pp, Moscow, 1961) surveying Soviet and non-Soviet information on radar methods of observing and investigating meteors. The following topics are included: use of radio techniques for observing meteors, certain problems in radiophysics and geophysics, and radioengineering aspects of observing meteors by radar.

5443 Report P-63-24, "Tracking of Missiles and Space Vehicles. Review of Soviet Literature," 21 Feb 63, (23:36), Unclassified, AD 298 592.

Brief abstracts are given of Soviet papers relating to the tracking of missiles and spacecraft; covers documents received from August through December 1962. Only three possess marginal pertinence to radar-reflection characteristics.

5444 Report P-63-118, "Tracking of Missiles and Space Vehicles. Compilation of Abstracts," 4 Nov 63, (23:30), Unclassified, AD 424 026.

Abstracts of 30 articles translated from Soviet publications appearing in late 1962 and early 1963. Topics treated here are: ion clouds and ionosphere perturbations, and radio astronomy. Entries are arranged alphabetically by author under these two subjects, and a few in each section pertain to radar reflectivity. A separate listing of the 30 references contains only bibliographic information.

5445 Report B-64-11, "Radio Astronomy Antennas and Processing of Radio Astronomy Data. Annotated Bibliography of Soviet Literature (Preliminary)," 4 Mar 64, (42:97), Unclassified, AD 431 787.

This is an annotated bibliography of 97 references from open-source Soviet literature related to radio-astronomy antennas and processing of radio-astronomy data. The bibliography is broken down into parts by year of publication and alphabetically by author within the parts.

5446 Report P-64-62, "Tracking of Missiles and Space Vehicles. Compilation of Abstracts," 13 Nov 64, (52:55), Unclassified, AD 608 886.

Abstracts of 55 articles translated from Soviet open literature published during the second half of 1963. Topics covered in this collection are ion clouds and ionosphere perturbations; reflection of electromagnetic waves from moon, sun,

LIBRARY OF CONGRESS, AEROSPACE TECHNOLOGY DIVISION (CONT.)

5446 (Cont.)

planets, or artificial satellites; and radio astronomy (radio emission, antennas, and quantum molecular oscillators). A few articles in the ionosphere section are marginally pertinent. A separate listing of the 55 references contains only bibliographic information.

LOCKHEED ELECTRONICS COMPANY

5447 Final Report (ASD-TDR-62-116), "Radar Safety System. Armament Training and Testing," W. L. McCulloh, AF 04(635)-2096, Nov 62, (13:0), Unclassified, AD 290 483.

In training exercises with radar-augmented towed targets, such at the TDR-9/B, there is need of some means to prevent the interceptor from inadvertently attacking the towing plane; this report describes a method of accomplishing this. The augmented radar return is amplitude-modulated at 10 cps, and this component in the detected return in the interceptor is used to provide an unmistakable indication of target acquisition. The modulation is accomplished by switching a controlled current through a diode modulator inserted in series in the augmenter transmission line, thereby varying the RF attenuation.

LOCKHEED MISSILES AND SPACE COMPANY

5448 Technical Report LMSD-288087, "General Research in Diffraction Theory: Volume 1," N. A. Logan, Dec 59, (1 vol.:87), Unclassified, AD 241 228.

Ray-tracing techniques of geometrical optics are generalized through a class of universal functions so as to predict amplitude and phase of an electromagnetic wave scattered by a convex metallic surface. The resulting diffraction integrals are generalizations of functions previously employed in studies of radio-wave propagation around the earth's surface. The functions are Fourier integrals having combinations of Airy integrals in the integrands. The Airy integrals and, particularly, the history of solutions for these functions are discussed in considerable detail, emphasizing the role played by the Taylor and Laurent series expansions. Since most practical diffraction problems lie in the higher frequency regions where classical solutions fail to converge readily and hence do not yield useful data, it is shown that divergent series can be summed in a classical manner to obtain "transition" region solutions. Asymptotic expansion of radiation fields for slot antennas on a circular cylinder are presented as an example of the application of these integrals.

Ed: Further volumes are mentioned as being planned, but were not obtained.

5449 Technical Report: Communications (Report 6-90-62-65), "Toward a Simple Mathematical Model for Microwave Backscatter from the Sea Surface at Near-Vertical Incidence," J. K. Parks, Jan 63, (48:18), Unclassified, AD 298 986.

A mathematical model is formulated for near-vertical backscatter in terms of Huygens' principle; the backscatter is expressed in terms of an "expected transfer function" of the round-trip path between antenna and sea surface. The probability density function of surface elevation is considered invariant over the microwave-illuminated area of the sea. The incident electromagnetic field is not assumed plane, and the antenna is not assumed located in the Fraunhofer zone of the scattering surface. Although the analysis is carried out in terms of a general probability-density function of sea-surface elevation, a detailed example assumes an approximately Gaussian density function. The model indicates that values of σ°, when measured at near-vertical incidence, cease to be

LOCKHEED MISSILES AND SPACE COMPANY (CONT.)

5449 (Cont.)

independent of range and antenna gain. An attempt is made to compare the theory with the few available experimental data, but results are not conclusive. In particular, for angles greater than 20° from the vertical, the theoretical curves do not fall off as rapidly as do the available data points.

5450 Report LMSC-A602037 (SP-63-39), "MSVP Bibliography," AF 04(695)-129, 1 Dec 63, (39:124), Unclassified, AD 426 404.

Unclassified abstracts of 124 Medium Space Vehicles Programs (MSVP) reports issued by Lockheed are arranged by subject, following a listing of bibliographic information for all entries. Few relate specifically to radar reflectivity.

5451 Technical Report LMSC-A632070 (Report 3-56-64-3), "Laser Radar for Space Missions: Exploratory Studies of the Major Factors," W. J. Burgess, R. G. Clow, D. G. Peterson, et al., AF 04(674)-787, Mar 64, (300:71), Unclassified, AD 465 200. (Information contained should not be released to Soviet Bloc countries.)

This large volume resulted from a four-month exploratory study on the feasibility of using laser radar in space. Besides the general state of the art, there are discussions on transmitting and receiving factors, radiation detectors, and target characteristics. The latter are treated only in a 7-page chapter without noteworthy general conclusions. The range equation is developed using Poisson statistics to describe the quantized signal and noise. Appendices include a treatment of "Quantum Effects in Communication Systems," by H. Heffner; "Use of Doppler Effects in Laser Radar," by H. V. Hance; and a bibliography of over 700 items on the general subject of lasers and their applications (together with a short subject index).

5452 Special Bibliography 61-69 (Report 3-80-61-44), "Radar: Detection, Discrimination, Decoys and Camouflage: An Annotated Bibliography," Compiled by G. R. Evans, Sep 62, (80:248), Unclassified, AD 400 124.

Listing, with a few abstracts and some DDC descriptors, of 248 mostly classified references issued between 1953 and December 1961. Entries are arranged by source or agency; most are pertinent to radar reflectivity. A short subject index is included.

5453 Special Bibliography 62-18 (Report 3-77-62-14), "R-F Blackout Phenomena: An Annotated Bibliography," Compiled by G. R. Evans, AF 04(647)-787, Apr 62, (80:150), Unclassified, AD 278 678.

Listing of 150 classified and unclassified documents concerning the causes of rf blackout to communication caused by plasma sheath around re-entry vehicles, and solutions to the problem; the period covered is 1959-February 1962. Arranged alphabetically by author, the entries consist mostly of abstracts. A 10-page subject index is included.

5454 Special Bibliography 62-23 (Report 3-80-62-11), "Data Handling Instrumentation for RF/IR Optical (Radar Characteristics) and Associated Equipment: A Report Bibliography," Compiled by G. R. Evans, May 62, (132:280), Unclassified, AD 296 347.

Collection of 280 classified and unclassified references concerning data-handling in ground-based electronic systems used to detect, identify, and track

LOCKHEED MISSILES AND SPACE COMPANY (CONT.)

5454 (Cont.)

guided missiles. Most entries contain only bibliographic information; abstracts are given for report series and occasional individual reports. A substantial subject index is included.

5455 Special Bibliography 62-38 (Report 3-80-62-25), "Radar Confusion Reflectors: An Annotated Bibliography," Compiled by G. R. Evans, Oct 62, (54:187), Unclassified, AD 296 383.

Listing of 187 mostly classified references concerned primarily with passive electromagnetic warfare, in particular chaff and rope. Entries are arranged by source or agency and contain mostly bibliographic information with occasional abstracts. References are dated from 1954; most are pertinent to radar reflectivity. A short subject index is included.

5456 Special Bibliography 63-64 (Report 8-40-63-12), "Electronic Countermeasures and Counter-Countermeasures: An Annotated Bibliography. Supplement No. 1," Compiled by G. R. Evans, NOw-63-0050-c, Jul 63, (180:463), Unclassified, AD 440 887.

Listing of 463 references, mostly classified, which pertain primarily to active ECM and ECCM in radar systems and radar systems integrated with radio communications systems. Specific topics include jamming, anti-jamming, deception, interception, interference, and decoys. A limited number pertain to absorbers, cross-sections, and other topics related to reflectivity. Most entries contain bibliographic data only; occasional abstracts and content notes appear. An author index and a 30-page detailed subject index are included. This bibliography is a continuation of LMSC 3-80-61-12/SB-61-43, Part 1: Electronic Countermeasures and Counter-Countermeasures: A Selective Bibliography, 1959-July 1961; Part II: Electronic Countermeasures and Counter-Countermeasures; A Report Bibliography, 1957-1958. (See also Abstract 5459 below.)

5457 Special Bibliography 64-7 (Report 5-10-64-2), "Bibliography of LMSC Bibliographies," Jan 64, (70:416), Unclassified, AD 439 261.

Listing of the 416 bibliographies, mostly unclassified, generated by the LMSC Technical Information Center between 1958 and 1963. Many of the documents are internal reports and hence not generally obtainable; of the others, several are pertinent to radar reflectivity. Subject and personal author indices are included.

5458 Special Bibliography 64-12 (Report 2-60-64-28), "Radar Simulation: An Annotated Bibliography," Compiled by G. R. Evans, NOw-63-0050-c, Jun 64, (70:154), Unclassified, AD 449 498.

Listing of 154 classified and unclassified references dealing with radar simulation by analog and digital computer techniques. Entries are dated between 1953 and June 1964 and are arranged alphabetically by author; about half are accompanied by abstracts. Few are directly pertinent to radar reflectivity. Source and subject indices are included.

5459 Special Bibliography 64-13 (Report 2-60-64-32), "Electronic Countermeasures and Counter-Countermeasures: An Annotated Bibliography. Supplement II (June 63-June 64)," Compiled by P. R. Stromer, NOw-63-0050-c, Jul 64, (102:-), Unclassified, AD 448 090.

LOCKHEED MISSILES AND SPACE COMPANY (CONT.)

5459 (Cont.)

(BD-7887) The literature of electronic countermeasures (ECM) and counter-countermeasures (ECCM) has been surveyed for the period June 1963-June 1964. Emphasis is on active ECM devices and techniques, especially as related to re-entry vehicle penetration aids. (See also Abstract 5456 above.)

5460 Special Bibliography 64-17 (Report B-07-64-3), "Penetration Aids: An Annotated Bibliography," Compiled by P. R. Stromer, Oct 64, (167:442), Unclassified, AD 451 665.

Listing of 442 classified and unclassified reports pertaining to penetration aids which were issued between June 1963 and June 1964. Authors' abstracts are provided; where no annotation is possible for security reasons, DDC descriptors are given. All reports are available from DDC and many are pertinent to radar reflectivity. An author index and a detailed subject index are included.

MARCHETTI (J. W.), INC.

5461 Final Report (RADC-TDR-64-303), "100 Megacycle VHF Re-entry Radar for Stallion Site, White Sands Missile Range, AN/TPQ-20," AF 30(602)-2824, Aug 64, (116:2), Unclassified, AD 607 043.

A technical description of system operation, testing, and calibration for the AN/TPQ-20 radar, a 100-Mc, 1-MW, variable-pulse width (1, 2.5, and 5 μsec) system used to obtain reflectivity data for Athena test vehicles.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, DEPARTMENT OF ELECTRICAL ENGINEERING

5462 Report ESL-AR-104(I), "Investigation of New Radar Components and Techniques--1960 Annual Report, Volume I," AF 33(616)-5489 and AF 33(616)-5477, Jun 61, (68:27), Unclassified, AD 264 349.

The report includes some twenty pages of discussion on the progress of a continuing theoretical investigation on the Woodward ambiguity function and derived concepts. Most of this is devoted to the theory of resolution of multiple targets, based on the superposition integral.

5463 Report ESL-R-131, "A Radar Theory Applicable to Dense Scatterer Distributions," A. Krinitz, AF 33(657)-7644 and AF 33(616)-5489, Jan 62, (64:11), Unclassified, AD 274 071.

This theoretical paper considers radar as a means of mapping a dense distribution of scatterers in two coordinates (x,y). It is assumed that a complex unit-scatterer return h(t,x,y), and a complex scatterer-density function $\psi(x,y)$, can be defined such that: (1) h(t,x,y) depends only on the radar; (2) $\psi(x,y)$ depends only on the scatterer distribution; (3) the complex video representation of the echo signal is

$$s(t) = \int_{-\infty}^{\infty} \psi(x,y)\ h(t,x,y)\ dxdy;$$

and (4) an x-y display of $\psi(x,y)$ approximates, in some practically useful way, a map of the distribution of scattering objects in the x-y plane. The above conditions are satisfied if x and y are taken to be time delay and Doppler frequency. Determination of $\psi(x,y)$ is assumed to be the objective of the radar.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, DEPARTMENT OF METEOROLOGY

5464 Quarterly Technical Report 5, "Weather Radar Research," P. M. Austin, DA 36-039 SC-71136, 15 Jun 57, (11:-), Unclassified, AD 138 075.

Brief description of progress on an evaluation of radar as a meteorological instrument.

Note: Other reports on this contract were listed in Abstract 2238.

5465 Technical Note 1 (AFCRC-TN-59-427), "Note on Vertical Variations in Radar Reflectivity," C. W. C. Rogers, AF 19(604)-2291, Jun 59, (14:6), Unclassified, AD 225 708.

Describes the results of a survey concerning variation of radar reflectivity with height in the lower levels of the atmosphere, based on RHI photographs taken at Great Blue Hill, Massachusetts, with a AN/CPS-9 3.2-cm radar. Only situations characterized by continuous non-showery precipitation were used. The total number of cases analyzed was 805; of these, 470 were in rain echoes below the bright band, and 335 were in snow. Very few cases showed detectable change in reflectivity with height in the lower levels of the atmosphere. The relationship between vertical-velocity profiles and variations in reflectivity with height is discussed. It is pointed out that larger vertical velocities and greater variation in reflectivity with height are observed in the middle atmosphere.

5466 S. M. Thesis, "Characteristics of New England Thunder Storms Viewed on 10 cm Radar," T. F. Stem, Jr., 20 Jan 64, (168:32), Unclassified, AD 432 778.

Thunderstorms were observed during the summer of 1963 with a 10.7-cm SCR-615-B radar and a 3.2-cm CPS-9 radar. Methods of collecting and analyzing data are discussed, along with sources of possible error. Radar observations of seven thunderstorms are analyzed in conjunction with synoptic data. Eighty pages of the report are given over to graphic and tabular presentation of radar and synoptic data. Each thunderstorm case is described separately and its most general characteristics are discussed. It was learned that the echoes were composed of a number of sub-cells, which grew and decayed cyclically. Larger echoes, termed "storm complexes," had life periods on the order of several hours and seemed to pulsate as the sub-cells grew and decayed.

5467 Biannual Report 2, "Application of Weather Radar to Intensity of Surface Precipitation," P. M. Austin, DA 36-039 AMC-02225(E), 30 Sep 64, (25:-), Unclassified, AD 452 774.

Comparison of radar reflectivity and rain-gauge measurements, based on raindrop samples and RHI and PPI intensity levels photographed in 55 storms on 10-cm SCR-615-B and 3.2-cm CPS-9 radars. Empirical relations between rainfall rate and radar reflectivity for several storm types are derived from simultaneous measurements of radar reflectivity, rainfall rate, and drop-size distributions. In most storms, agreement between equivalent rainfall rates (based on $Z = 200 R^{1.6}$) and rates measured by rain gauge is well within a factor of two. In a study of the relations between precipitation rate and radar reflectivity for snow, measured radar reflectivities are compared with hourly precipitation amounts and the dependence of reflectivity on temperature as well as precipitation rate is considered. The extent to which precipitation in the volume of space sampled by the radar is representative of that which reaches the ground is studied, through detailed observations of reflectivity variation with height and through comparison of radar and precipitation measurements at various ranges. The dispersion of radioactive debris from nuclear surface detonations in model wind fields is computed,

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, DEPARTMENT OF METEOROLOGY (CONT.)

5467 (Cont.)

in an attempt to obtain models from which distribution estimates in actual or predicated wind fields and storms may be used.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, LINCOLN LABORATORY

5468 Semiannual Technical Summary Report, 1 Oct 58-30 Jun 59, "Reentry Physics Program," AF 19(604)-4559, ARPA Order 13-59, 8 Oct 59, Unclassified, AD 228 431.

(BD-757) Abstract not available.

5469 Semiannual Technical Summary Report, 1 Jul-31 Dec 59, "Reentry Physics Program," AF 19(604)-5200, ARPA Order 13, 23 Mar 60, Unclassified, AD 234 627.

(BD-3858) Abstract not available.

5470 Semiannual Technical Summary Report, 1 Jan-30 Jun 60, "Reentry Physics Program," AF 19(604)-4559, ARPA Order 13, 5 Aug 60, Unclassified, AD 241 226.

(BD-1041) Topics include re-entry phenomena, re-entry plasmas, and electromagnetic scattering.

5471 Semiannual Technical Summary Report, 1 Jul-31 Dec 60, "Reentry Physics Program," AF 19(604)-7400, ARPA Order 13, 8 Feb 61, (-:6), Unclassified, AD 252 669.

(BD-829) Topics include re-entry plasmas and radar scattering.

5472 Semiannual Technical Summary Report, 1 Jan-30 Jun 61, "Reentry Physics and Project PRESS Programs," AF 19(604)-7400, ARPA Orders 13-61 and 166-61, 3 Aug 61, Unclassified, AD 262 543.

(BD-1601) Topics of interest are electronic properties of reentry plasmas including electron-density measurements in the wakes of hypervelocity pellets, Doppler measurement of wake velocity and electromagnetic reflectivity, and turbulence experiments; electromagnetic interactions with reentry plasmas including scattering from an infinite cylinder having a radially varying dielectric constant, and scattering from concentric plasma shells.

5473 Semiannual Technical Summary Report, 1 Jul-31 Dec 61, "Reentry Physics and Project PRESS Programs," AF 19(604)-7400, ARPA Orders 13 and 166, 9 Feb 62, (202:35), Unclassified, AD 273 072 or AD 416 142.

This report summarizes information on a multitude of subjects concerning re-entry problems; only a small portion deals with reflectivity properties. A short section presents preliminary radar cross-section models for underdense and overdense plasmas and discusses the penetration of the electromagnetic field. Another section describes transmission and reflection in a waveguide containing the ionized wake of a hypervelocity pellet. A third section treats scattering from an infinite plasma cylinder having a homogeneous and a radially varying complex dielectric constant. Reference is made to other reports for more detailed discussions of the work.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, LINCOLN LABORATORY (CONT.)

5474 Semiannual Technical Summary Report, 1 Jan-30 Jun 62, "Reentry Physics and Project PRESS Programs," AF 19(604)-7400, ARPA Orders 13 and 166, 7 Aug 62, Unclassified, AD 283 478.

(BD-3471) Topics include: flow fields and reaction kinetics; hypervelocity ballistic range experiments; electromagnetic scattering from wake plasmas; and field-data analysis.

5475 Quarterly Progress Report, Division 3, "Radio Physics," 15 Apr 62, (9:6), Unclassified, AD 275 470 or AD 415 729.

Brief reports on lunar and solar radar studies, launch-phase detection of missiles by ionospheric backscatter, and incoherent backscattering from the ionosphere at UHF.

5476 Quarterly Progress Report, Division 3 (ESD-TDR-62-116), "Radio Physics," 15 Jul 62, (10:2), Unclassified, AD 283 035.

The studies briefly summarized include analysis of backscatter from the sun at 38 Mc; results show the cross-section of the sun to be about 8×10^{17} m^2, assuming that all return energy is contained in a bandpass of 8 kc and is equally distributed between the orthogonal polarizations. The cross-section varies from day to day and this fluctuation may correlate with the 27-day solar rotation period. Other observations (barely mentioned) include launch-phase observations on missiles, and echoes from meteor trails and the moon.

5477 Quarterly Progress Report, Division 3 (ESD-TDR-64-364), "Radio Physics," AF 19(628)-500, 15 Aug 64, (5:0), Unclassified, AD 446 691.

Very brief discussions of backscatter observations of Venus and Mercury by the Millstone radar, and of Venus by the El Campo radar.

5478 Quarterly Progress Report, Division 3 (ESD-TDR-64-576), "Radio Physics," AF 19(628)-500, 15 Nov 64, (5:0), Unclassified, AD 609 014.

Includes very brief summaries of L-band radar observations of Venus, and of ionospheric and atmospheric backscatter.

5479 Technical Report 101, "An Investigation of a 2-Mcps Ground-Wave Radar for Ship Detection," J. T. deBettencourt and D. J. Gray, AF 19(122)-458, 13 Dec 55, (20:5), Unclassified, AD 90 351.

An investigation of the practicality of using ground-wave radar for detecting ships. The 1.95-Mc, vertically polarized Loran station on Nantucket Island, Massachusetts, was used as a transmitter, giving a pulse length of about 50 μsec between half-power points (150 μsec overall), peak power of 800 kw, and a repetition rate of 33 pps. A separate receiving site on the island was used to avoid the need for a TR device. Both a non-directive whip antenna and the combination of the whip and a loop to give a slightly directive cardioid antenna pattern were used at the receiver. Clutter was definitely established as coming from the open sea, and had a fading range of about 10 to 20 dB, with a fading rate of 0.1 to 0.5 cps. There was apparent correlation between clutter amplitude and sea state. Six half-wave dipoles with parachutes were dropped from an aircraft at ranges of 20 to 50 miles during detection tests, but no returns could definitely be attributed to these targets. Plots show the variation with range of clutter amplitude and the calculated dipole return for four test days. It is concluded

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, LINCOLN LABORATORY (CONT.)

5479 (Cont.)

that the clutter would prevent detection of ships unless clutter-reduction techniques were used. Suggestions include: narrower antenna beam (about 10°), shorter pulse length (about 10 μsec), and narrow-band filtering within the clutter spectrum.

5480 Technical Report 187, "Characteristics of Moon-Reflected UHF Signals," S. J. Fricker, R. P. Ingalls, W. C. Mason, et al., 22 Dec 58, (60:14), Unclassified, AD 204 519.

The moon's radar cross-section was measured in August 1957 and found to be 7×10^{11} m^2 at 412.85 Mc. The experiment was conducted to determine characteristics of UHF radiation propagating through the ionosphere into space. The CW transmitter had a power of 40 kw, and used a 60-ft parabolic antenna located at South Dartmouth, Mass. The receiver was located at Alpha, Maryland, and employed a 28-ft parabolic antenna. The entire system is outlined; measurements of Faraday rotation, fading, Doppler shift, and received signal power are discussed.

5481 Technical Report 256 (AFESD-TDR-62-77), "Radio-Echo Observations of the Moon at 3.6-cm Wavelength," J. V. Evans, 19 Feb 62, (38:24), Unclassified, AD 274 669.

The reflection properties of the moon were measured at 3.6 cm. Results indicate the surface is rougher at 3.6 cm than for meter wavelengths. Some 30% of the reflected power is returned from scatterers that are uniformly distributed over the surface. The remainder is reflected from the central quarter of the visible disk. In this region, the surface appears to be describable by means of a Gaussian spatial autocorrelation function with a mean surface gradient of one in three. (Compare Abstract 5501.)

5482 Technical Report 266, "Electromagnetic Studies of Ionized Wakes," E. L. Murphy, S. Edelberg, and G. F. Pippert, AF 19(604)-7400, ARPA Order 13, 20 Apr 62, (-:14), Unclassified, AD 282 309.

(BD-3364) Data on ionized trails behind hypersonic pellets were obtained in three ways: microwave horns to measure electromagnetic complex reflection and transmission coefficients for the region of trail illuminated by the horn; microwave cavities designed to measure the complex admittance of the portion of the trail within the cavity; and double Langmuir probes to measure local plasma density. The three methods of measurement and corresponding analysis for data reduction are described. A model is adopted for the ionized region which makes it possible to relate the electromagnetic parameters to quantities such as electron density, collision frequency, and their space and time distribution. These quantities are related to flow and thermodynamic variables.

5483 Technical Report 272 (ESD-TDR-62-241), "Radio-Echo Observations of the Moon at 68-cm Wavelength," J. V. Evans, AF 19(604)-7400, 22 Jun 62, (24:37), Unclassified, AD 291 102.

Short-pulse radio-echo studies of the moon were conducted at a wavelength of 68 cm. Results are compared with data available from 3.6-cm and 10-cm measurements. Equipment is briefly described. Comparison of cited results with other data shows that angular scattering of the lunar surface is wavelength dependent. Polarization is also treated.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, LINCOLN LABORATORY (CONT.)

5484 Technical Report 273 (ESD-TDR-62-149), "Scattering of Electromagnetic Waves by an Eaton Lens," J. Rheinstein, AF 19(604)-7400, 28 Jun 62, (43:20), Unclassified, AD 289 380.

Results are given for rigorous calculations of both monostatic and bistatic scattering by an Eaton-Lippmann (generalized Luneburg) lens composed of layers of nonlossy dielectric material with a central core. These data are compared with the properties of an ideal Eaton lens whose dielectric constant varies continuously as a function of radius, derived according to geometrical optics. It is concluded that a layered Eaton lens is nether exceptionally good nor exceptionally poor as a reflector in the backward direction. Pertinent discussions related to the following are presented in appendices: derivation of the equation for the ray path through an Eaton lens, zero backscatter of Eaton lens, and a program for calculating scattering by a lossless, layered, spherical dielectric.

5485 Technical Report 282 (ESD-TDR-62-279), "Radar Astronomy Measurement Techniques," P. E. Green, Jr., AF 19(628)-500, 12 Dec 62, (78:74), Unclassified, AD 400 563.

An excellent review of techniques for studying objects of interest in radar astronomy, which are usually "spread" targets. The report is a sequel to an earlier one ("Signal Processing in Radar Astronomy Communication via Fluctuating Multipath Media," R. Price and P. E. Green, Technical Report 234, MIT Lincoln Lab, 6 Oct 60, Unclassified, AD 246 782), in which is given a rather complete treatment of detection theory for spread targets. Here interest is in measurement rather than detection. Spread targets are defined as those producing observable smearing of the echo in range, or an observable rate of echo fluctuation, or both. Spread targets may or may not be extended targets, i.e., targets having finite angular extension.

After examining changes in the various attributes (e.g., amplitude, delay, phase, frequency shift, polarization) of an incident signal upon reflection from such a target, the question is reversed by detailing how study of these signal attributes through receiver processing can be used to infer target properties (the inverse scattering problem). For rotating planets, these target properties might include range, velocity, shape, size, rotation vector, and surface characteristics. (The last of these might be studied either as average behavior over the target surface or as a function of location on the target surface.) Various possible transmitted signals are considered. Receiver operations considered include processing of the echo received at spaced receivers (interferometry), processing of separate components received at the same point (polarimetry), and the common case of processing the output of a single receiver. A short appendix examines the range-Doppler distribution of return from a rough rotating sphere.

5486 Technical Report 294 (ESD-TDR-63-36), "Photo-Ionized Cloud as Source for Decrease in Backscatter Cross Section of Re-entering Body," E. L. Murphy, AF 19(628)-500, ARPA Order 13, 17 Jan 63, (11:7), Unclassified, AD 401 310.

Experimental results obtained on the Trailblazer I series of re-entry vehicles at UHF- and S-bands showed strong reductions in cross-section prior to a 20- to 30-dB enhancement that begins at altitudes between 180,000 and 150,000 ft; in some cases, the reductions were in the order of 15 dB. This report considers the possibility that ultra-violet-produced ionization causes the observed initial reduction in cross-section; for example, by refracting the incident energy away from the central scatterer. Preliminary theoretical results show decreases as large as 20 dB.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, LINCOLN LABORATORY (CONT.)

5487 Technical Report 305 (ESD-TDR-63-550), "Improvement of the Measurement Capability of the UHF Radar at Wallops Island," J. Freedman, Editor, AF 19(628)-500, ARPA Order 13, 10 Apr 63, (58:1), Unclassified, AD 417 559.

This report describes a program undertaken to modify the UHF radar system at Wallops Island, Va. This program, successfully completed in December 1962, was designed to improve range resolution from 1000 to 200 ft and to extend from 400 to 1200 fps the ability to measure unambiguous Doppler velocity.

5488 Technical Report 322 (ESD-TDR-63-563), "Properties of Dielectrics from Reflection Coefficients in One Dimension," H. E. Moses and C. M. deRidder, AF 19(628)-500, ARPA Order 13, 11 Jul 63, (47:4), Unclassified, AD 422 444.

(BD-7895) This report presents mathematical techniques for calculating dielectrics which give rise to prescribed reflection coefficients in certain problems of one-dimensional electromagnetic propagation. The techniques are, in principle, exact, and are based on the use of an equation of the Gel'fand-Levitan type for the one-dimensional Schrödinger equation. No practical applications are given.

5489 Technical Report 329 (ESD-TDR-63-589), "The Reduction of Electromagnetic Backscatter from a Plasma-Clad Conducting Body," E. L. Murphy, AF 19(628)-500, ARPA Order 13, 23 Sep 63, (21:7), Unclassified, AD 430 589.

Efforts to explain observed large decreases in radar cross-section for re-entry bodies have usually presumed the decreases to result from absorption in high-collision-frequency regions of the shock wave, or from refractive effects in effectively collisionless regions at greater distance from the body where photo-ionization may occur. Neither of these causes seems likely to produce the large reductions observed. This report considers the possibility that resonance effects in a large, collisionless ionized cloud surrounding the body may produce the observed effects. The properties of the resonance-dip phenomenon are examined for a uniform dielectric layer on a conducting core of either spherical or cylindrical shape. It is shown that large dips in backscatter cross-section considerably below the bare core value can occur when a collisionless uniform layer surrounds the core.

5490 Technical Report 331 (ESD-TDR-63-582), "Radar Observations of the Moon at 8.6-mm Wavelength," V. L. Lynn, M. D. Sohigian, and E. A. Crocker, AF 19(628)-500, 8 Oct 63, (24:8), Unclassified, AD 426 207.

Discussion of equipment and rationale for obtaining data on radar reflection from the moon at 8.6 mm. At this wavelength, the total radar cross-section measures 7% ± 2% of the geometric cross-section. Diffuse scattering accounts for about 85% of reflected power. Variation in reflectivity between the maria and the continents was insignificant, staying within limits of ± 2 dB. Data are compared with lower frequency observations. Procedures for calibration and for determining lunar position are given.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, LINCOLN LABORATORY (CONT.)

5491 "Radio-Echo Studies of Meteors at 68-cm Wavelength," J. V. Evans and R. A. Brockelman, AF 19(628)-500, Unclassified.

Description	Title	Date	Pages:Refs.	AD No.
Technical Report 332 (ESD-TDR-63-581)	Part I: Sporadic Meteors	29 Oct 63	59:50	439 354
Technical Report 341 (ESD-TDR-64-17)	Part II: Shower Meteors	15 Jan 64	59:21	601 518

These two reports describe radio-echo observations of meteors made at 68 cm as part of a program carried out between 1960 and 1962 at the Millstone Hill Radar Observatory. In the first, equipment and procedures for data collection and reduction are described. Sufficient information was gathered to allow velocity, height, duration, and intensity to be computed for most of the meteors; the interrelation of these quantities is explored. Principal conclusions reached are: (1) meteors recorded at this short wavelength are seen over a height range not sensibly different from that at long wavelengths; (2) effective scattering lengths of the trails are short (50 meters or less); (3) overall lengths of the trails average 6 to 7 km; and (4) evidence of fragmentation is found in about half the observations. The visual magnitude of these meteors has been estimated from their rate and corresponds to +8, and the short effective scattering length is attributed to a rapid initial expansion of the trail diameter.

Part II discusses radio-echo observations of five nighttime meteor showers. Values for the meteor velocities are compared with values from other sources; mean heights and trail lengths of these meteors are also given. Velocity and deceleration were measured very precisely for Quadrantid and Geminid meteors by directing the radar beam along the path of the approaching meteors and determining velocity directly from the Doppler shift. These precise deceleration measurements are compared with the simple meteor theory for the case of free molecular flow, and it is found that in a large number of cases the theory is inadequate and that cap formation for these meteors begins at heights somewhat above 100 km.

5492 Technical Report 349 (ESD-TDR-64-37), "Radar Scattering from a Conducting Cone-Sphere," J. H. Pannell, J. Rheinstein, and A. F. Smith, AF 19(628)-500, 2 Mar 64, (36:9), Unclassified, AD 600 411.

Radar backscattering measurements were made at pulsed, short-pulse, and CW reflectivity ranges for models of the cone-sphere fabricated to give ratios of spherical-segment radius to wavelength ranging from 0.60 to 10.43. Measurement frequencies ranged from 550 Mc to 35 Gc. Both horizontal and vertical polarization measurements were made. A total of 18 polar plots of radar cross-section data are presented and a table is included in which predicted maxima and minima are compared with experimental results; satisfactory agreement was obtained for all aspect angles.

5493 Technical Report 369 (ESD-TDR-64-591), "Study of an Orbiting Dipole Belt Communication System," F. Belvin and T. J. Goblick, Jr., AF 19(628)-500, 22 Dec 64, (79:28), Unclassified, AD 613 583.

Problems of communicating via a single equatorial dipole belt at an altitude of 8000 miles, assuming an 800-kg payload of X-band copper dipoles. Major items considered are: (1) the physical characteristics of the belt; (2) coverage and visibility; (3) channel characteristics; and (4) communications techniques and

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, LINCOLN LABORATORY (CONT.)

5493 (Cont.)

link design. The dipole belt is defined as having an average bistatic scattering cross-section σ in the common volume of receiving and transmitting antennas given by $\sigma = N_c \times a(\gamma)$, where N_c = number of dipoles in the common volume, $a(\gamma)$ = average scattering cross-section of a single dipole with random orientation, and γ is the bistatic angle. The cross-section is used in the bistatic transmission equation to calculate channel-transmission losses.

Ed: The scattering cross-section is lightly treated, emphasis being on other system parameters such as transmitted power, antenna beamwidths, noise temperature, etc.

5494 Group Report 21G-0011, "UHF Radar for Reentry Physics Program," B. G. Kuhn, AF 19(604)-7400, 19 Sep 60, (73:-), Unclassified, AD 244 586.

Detailed description of the UHF-band radar located at Wallops Island, Va. This radar is one of three, operating at UHF-, S-, and X-bands, which are used to measure the cross-section of re-entry bodies. The S-band radar, which has automatic-tracking capability, tracks the re-entry vehicles; the other two radars are slaved to the S-band system. The UHF radar is designed to give a received SNR of 6 dB from a 5-inch sphere at a range of 200 nmi. It operates at 420-450 Mc, has peak power of 7.8 MW, a beamwidth of 2.9°, pulsewidth of 6.3 μsec, and prf of 320. Vertical polarization is transmitted and both vertical and horizontal received. The report includes no cross-section data. (See also next two abstracts.)

5495 Group Report 21G-0013, "X-Band Radar for Reentry Physics Program," J. Sobolewski, F. J. Dominick, E. E. Schowengerdt, and L. C. Wilber, AF 19(604)-7400, 7 Dec 60, (76:3), Unclassified, AD 252 043.

Detailed description of the X-band radar located at Wallops Island, Va., which is a part of the MIT re-entry physics program. The transmitter is essentially an APS-20E S-band radar transmitter modified to operated at X-band. The few modifications required are described in moderate detail along with unmodified transmitter circuits. Frequency is 9340-9440 Mc, peak power is 1.0-1.2 MW, beamwidth is 0.18°, pulse width is 2.6 μsec, and prf is 320. Vertical polarization is used. (See also abstracts preceding and following this.)

5496 Group Report 21G-0015, "Amplitude Calibration for Reentry Physics Program: Arbuckle Neck Radars," B. G. Kuhn, AF 19(604)-7400, 19 Sep 60, (39:0), Unclassified, AD 245 324.

Description of calibration techniques for three instrumentation radars used to measure the cross-sections of re-entry bodies. No cross-section data are included. (See preceding two abstracts.)

5497 Group Report 22G-16 (ESD-TDR-63-79), "Tables of the Amplitude and Phase of the Backscatter from a Conducting Sphere," J. Rheinstein, AF 19(628)-500, 19 Jun 63, (44:5), Unclassified, AD 409 820 or AD 413 103.

A series of calculations were performed on an IBM 7090 computer to determine the backscatter cross-section of perfectly conducting spheres with a radius-to-wavelength ratio varying from 0.01 to 19.00, at intervals of 0.01 or less. The data are presented in both graphs and tables.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, LINCOLN LABORATORY (CONT.)

5498 Group Report 3G-0002, "The Distribution of Electrons in the Upper Ionosphere from Backscatter Observations," J. V. Evans, AF 19(604)-7400, 23 Nov 60, (20:44), Unclassified, AD 247 860.

A summary of methods by which information has been obtained concerning the distribution of electrons above the level at the critical frequency of the F2 region. Electron density profiles from rocket firings and other techniques are compared with results of Pineo, et al., (Abstract 7699J) from observations of ionospheric backscatter. Most methods yield profiles in which the electron density diminishes only as rapidly or less rapidly than that in a Chapman region, whereas the results of Pineo always indicate a more rapid decay than predicted by Chapman theory. No explanation is available for the discrepancy. (Corrections to the work appeared in a later supplement, see next abstract; see also Abstract 5505.)

5499 Group Report 3G-0002, Supplement 1, "The Distribution of Electrons in the Upper Ionosphere from Backscatter Observations," J. V. Evans, AF 19(604)-7400, 3 Apr 61, (9:0), Unclassified, AD 254 143.

Previously published (see preceding abstract) electron-density distributions are corrected in this supplement. The correction brings the result into close agreement with that expected for a Chapman region and with some experimental measurements but not all.

5500 Group Report 3G-0003, "Radio Communication Using Moon Reflected Signals," J. V. Evans, AF 19(604)-7400, 19 Dec 60, (32:29), Unclassified, AD 249 355.

The properties of a moon-reflection radio-communication system are reviewed. A compilation of the best results obtained from Lincoln Laboratory, Jodrell Bank, and Royal Radar Establishment is used to examine: frequency and depth of signal fading; "path loss" for CW signals; distribution of echo power with range; and correlation of fading between two signals of slightly differing frequencies. New results are outlined for the bandwidth of the system; these were obtained by measuring the demodulation of a double-sideband AM signal as a function of modulation frequency. Three communication systems which could overcome some of the limitations of a single-channel circuit are discussed. A theoretical examination relates channel bandwidth to distribution of echo power with range.

5501 Group Report 3G-0004, "The Scattering Properties of the Lunar Surface at Radio Wavelengths," J. V. Evans, AF 19(604)-7400, 10 Jan 61, (42:39), Unclassified, AD 250 684.

A review of the best experimental results available in 1961 concerning radio-reflection properties of the moon. Observations by many workers to determine the radio albedo of the moon are compared and shown to yield a value of approximately 0.08, which corresponds to a relative dielectric constant of 2.7 for the surface materials. This is similar to that observed for dry terrestrial sand, and suggests that the surface is porous in texture. Distribution and character of the scattering centers on the lunar surface have been determined by measuring both echo amplitude auto-correlation and echo power as a function of distance from the moon's leading edge. These two techniques are shown to yield comparable results, assuming the signals to be reflected from many incoherent scatterers.

Review of attempts by four authors to account for the radar observations with a statistical description of the lunar surface shows that a Gaussian distribution of lunar surface slopes (suggested by three authors) is not a good description of

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, LINCOLN LABORATORY (CONT.)

5501 (Cont.)

the surface. Instead, a greater abundance of low-gradient slopes than given by the Gaussian distribution better fits the results. The mean surface gradient is approximately 1 in 40. (Compare Abstract 5481.)

5502 Group Report 30-0003, "A Preliminary Investigation of Meteor Echoes at U.H.F.," G. H. Pettengill and V. C. Pineo, AF 19(604)-5200, 16 Mar 60, (10:0), Unclassified, AD 235 669.

Results of a preliminary investigation of meteor-echo characteristics at 440 Mc using the Millstone Hill Radar. Meteor velocity was determined through Doppler-shift measurements. Histograms of height and velocity distributions appear along with a cumulative distribution of echo durations; it appears possible to determine meteor velocity with moderate accuracy for about half the observations.

5503 Group Report 30G-0004, "Millstone Observations during the NASA Shotput IV Experiment, 1 April 1960," D. P. Hynek, AF 19(604)-5200, 20 Apr 60, (14:-), Unclassified, AD 236 129.

Observations on the fourth in a series of firings of two-stage vehicles carrying test versions of the 100-ft spherical reflective balloon designed for Project Echo. The Millstone Hill radar operating at 440 Mc tracked the balloon from separation to re-entry and for several minutes after entrainment in the atmosphere. Radar cross-section was calculated to be on the order of 500 m^2. No significant interference patterns in the echo signal were observed during flight. Of particular interest to studies of upper-atmosphere density are observations of high deceleration, reduced cross-section, and markedly increased scintillation beginning abruptly at an altitude of 45 to 50 nmi.

5504 Group Report 30G-0008, "Some Characteristics of Ionospheric Backscatter Observed at 440 Mcps," V. C. Pineo, L. G. Kraft, and H. W. Briscoe, AF 19(604)-5200, 6 Jul 60, (15:5), Unclassified, AD 239 487.

Describes intensity and frequency-spectrum observations made of 440-Mc radar returns incoherently backscattered from the ionosphere at heights of about 100 to 800 km. Backscatter intensity is related to electron density, and deduced height profiles of electron densities are presented. The computed average scattering cross-section of an individual electron is approximately equal to the square of the classical electron radius. One typical frequency-spectrum measurement at 440 Mc indicates a half-power spectrum width of about 11 kc, at a height of about 300 km, during mid-afternoon of a March day.

Note: A journal article was published with the same title, see Abstract 7699J.

5505 Group Report 30G-0014, "Distribution of Electrons in the F Region," J. V. Evans, AF 19(604)-7400, 15 Sep 61, (35:51), Unclassified, AD 263 902.

Continuation of the work described in Abstracts 5498 and 5499 above. Electron-density measurements throughout the F-region of the ionosphere were made by the incoherent backscatter technique at the Millstone Hill Radar Facility operated by the MIT Lincoln Laboratory. Most observations were made late in 1960; all were made during the daytime. The shape of the profiles obtained is examined and found to agree with the theory of Yonezawa (e.g., T. Yonezawa and H. Takahashi, J. Radio Res. Lab (Japan) 7, 335 (1960)).

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, LINCOLN LABORATORY (CONT.)

5506 Group Report 30G-2 (ESD-TDR-62-72), "Radar Cross-Section Observations of the Echo I Communications Satellite at 440 Mc/s," D. P. Hynek, AF 19(604)-7400, 19 Feb 62, (94:0), Unclassified, AD 274 065.

Contains cross-section measurements conducted by the Millstone Hill Radar on Echo I, from August 1960 to October 1961. Nearly 100 revolutions were tracked, and amplitude data was recorded on about 35. Average cross-section and fading characteristics are included. Interest was on investigating shape distortion due to micrometeorites and the effects of thermal shock upon entering the earth's shadow.

Amplitude was fairly constant (about $\pm$ 0.5 dB, peak to peak) on the early revolutions, implying little deformation. On later revolutions, fast scintillation as well as slow fading was noted, suggesting a gradual deterioration in shape which caused generally rough amplitude plots with fades of $\pm$ 10 dB. The running average σ measured was comparable to the theoretical value of about 750 m^2; the average decreased on later revolutions.

Ed: Eighty-two of the report's 94 pages are given over to reproductions of strip-chart records, many of which are illegible in the DDC-reproduced copy.

5507 Group Report 33-9, "Observations at Round Hill on Shot Put II," L. P. Rainville, AF 19(604)-5200, 1 Mar 60, (26:-), Unclassified, AD 235 246.

Observations were made on the second in a series of test firings of two-stage vehicles carrying test versions of the 100-ft spherical reflective balloon designed for Project Echo. Reflections from the ejected test balloon were measured at the Round Hill Field Station at frequencies of 50, 425, 675, and 960 Mc. Observations indicated that it is possible to receive reflections at all these frequencies. The 960-Mc system received transmissions on one polarization via the balloon from a station at Holmdel, New Jersey.

5508 Group Report 33G-0014, "Convection and Diffusion of Ionization in the E-Layer," H. Feshbach and F. Villars, AF 19(604)-7400, 1 Dec 60, (48:17), Unclassified, AD 248 362.

It has been suggested that auroral backscattering of radio waves at frequencies from 100 to 800 Mc is due to the joint action of turbulence and the earth's magnetic field, which is assumed to produce small elongated irregularities of ionization aligned with the field. In this work, solutions were investigated for the equation for diffusion and transport of ionization in a weakly ionized turbulent plasma in the presence of a magnetic field. Due to space-charge effects, the problem is non-linear in the ionization density. It is shown that in the linearized approximation, the effect of the magnetic field on turbulence does not lead to small enough irregularities to explain the observed data.

5509 Group Report 34-84, "A Summary of Detection Theory Notions in Radar Astronomy Terms," P. E. Green, Jr., AF 19(604)-5200, 18 Jan 60, (28:10), Unclassified, AD 245 698.

A range-Doppler mapping scheme is proposed for investigating the properties of a rough, rotating target such as the moon. Brief comments are made on the distribution of return in range and in Doppler shift, the role of the ambiguity function for the transmitted waveform is mentioned, and the detectability of the return is also briefly noted.

Note: This material consists essentially of a paper presented at the URSI Fall Meeting, 21 October 1959.

5510 Group Report 34G-0005, "A Computer Program for Processing Signals Received in Radar Astronomy Experiments," P. L. Fleck, Jr. and T. J. Goblick, AF 19(604)-7400, 14 Oct 60, (20:6), Unclassified, AD 245 549.

Description of a computer program written to process data obtained from Venus radar reflections obtained by Lincoln Laboratory in 1958 and 1959. An IBM 709 computer and FORTRAN programming language were used. (See also Abstract 5521.)

5511 Group Report 34G-4, "Maximum Likelihood Estimation of the Correlation Function of a Threshold Signal, and Its Application to the Measurement of the Target Scattering Function in Radar Astronomy," R. Price, AF 19(604)-7400, 25 May 62, (31:5), Unclassified, AD 276 903.

This mathematical treatise is concerned with detection theory for threshold conditions such as occur in radar astronomy, where the signal is weak relative to the noise. Maximum-likelihood estimates are obtained for both signal correlation function and the scattering function of a target. Attention is on a radar astronomy environment where the propagation medium has mutually independent, statistically stationary fluctuations at a multiplicity of delays. The scattering function is used to link the correlation function of the echo signal to the transmission employed.

5512 Group Report 36G-2 (ESD-TDR-62-243), "Microwave Cross Section of Thin Dipoles," C. L. Mack, Jr., AF 19(628)-500, 15 Nov 62, (31:18), Unclassified, AD 291 231.

An attempt was made to "elongate" short dipoles into half-wave resonators, suitable for application in forming a belt of resonant scatterers in orbit around the earth. The measurement program was divided into four sections: (1) attempts to increase the effective cross-section of unit mass or volume of orbiting payload by means of magnetic or dielectric materials; (2) measurement of various properties of non-ideal dipoles; (3) acquisition of empirical data over ranges of diameter, resistivity, and frequency, to enable the cross-section of unmeasured dipoles to be estimated with reasonable accuracy; and (4) the study of tin dipoles during transformation from the normal metallic state to semiconducting state, as a possible contribution to the development of disposable dipoles. A short but rigorous method of calculating the skin impedance of straight cylindrical wire is given, along with a method of approximating the backscatter cross-section of half-wave dipoles cut from such wire. The attempt at elongation was not a success, since the mass of a dipole was increased by 120% and the optical cross-section by 50% while the elongation amounted to less than 4%.

5513 Group Report 312G-0001, "Radar and Optical Observations on Re-Entry of the Trailblazer I (D-58) Test Vehicle of June 4, 1959," H. L. Kasnitz, AF 19(604)-4559, May 60, Unclassified, AD 249 718.

(BD-1052) Abstract not available.

5514 Group Report 312G-0001-1, "Radar and Optical Observations on Reentry of the Trailblazer I (D-58) Test Vehicle of March 29, 1960," H. L. Kasnitz, AF 19(604)-4559, ARPA Order 13, Jun 60, Unclassified, AD 255 950.

(BD-1253) Abstract not available.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, LINCOLN LABORATORY (CONT.)

5515 Group Report 312G-0002, "An S-Band System for Measurements of Scattering from Hypervelocity Models," H. G. Pascalar and D. E. Crook, AF 19(604)-7400, Oct 60, (36:-), Unclassified, AD 250 799.

Detailed description of a CW, balanced-bridge, S-band RCS measurement range designed to measure both phase and amplitude of forward and backward scattered components from the ionized trails following model targets. The models are fired from a hypervelocity gun into a tunnel evacuated to upper-atmosphere pressures. System sensitivity was designed to detect backscattering voltage reflection coefficients of -50 dB and greater. Measured and calculated reflection ratios were in agreement to within 0.6 dB for 0.010-inch copper wire, a 0.750-inch aluminum sphere, and a 0.750-inch nylon sphere, all dimensions being diameters.

5516 Group Report 312G-4 (AFESD-TDR-62-70), "Scattering from a Homogeneous Plasma Cylinder of Infinite Length," C. M. deRidder and L. G. Peterson, AF 19(604)-7400, ARPA Order 13, 15 Jan 62, (91:0), Unclassified, AD 274 067.

This report deals with scattering of electromagnetic waves from an infinite cylinder of homogeneous plasma having a uniform but complex dielectric constant. Solutions were obtained using a digital computer. Seventy-seven curves (the bulk of the report) show the dependence of transmission and reflection coefficients and their phases on plasma frequency and cylinder radius. Two different collision frequencies are used. All quantities were normalized to eliminate dependence on the operating frequency. A plane wave incident normal to the cylinder axis is assumed. Both transverse magnetic and transverse electric cases are considered.

5517 Group Report 315G-5 (AFESD-TDR-63-47), "A Discussion of the Use of a System of Passive Satellites in Stationary Orbits for Radio Communication," R. N. Assaly, AF 19(628)-500, 28 Feb 63, (29:-), Unclassified, AD 402 841.

Discussion of the general aspects of a communication system using satellites in stationary orbits as passive reflectors. Thin-walled, metal-coated balloons are studied as reflectors, and the weights of different shapes are compared for the same cross-section. Also studied was the coverage of a satellite system in which each satellite is designed so that it scatters the energy within a limited angular range.

5518 Group Report 42G-7004 (sic), "Some Pitfalls in the Measurement of Target (Radar) Cross Section," W. W. Ward, AF 19(604)-7400, 12 Apr 61, Unclassified.

(BD-2757) Abstract not available.

5519 Group Report 45-42, "Radar Returns from Birds, and Their Elimination from Radar Outputs," R. E. Richardson, J. M. Stacey, H. M. Kohler, and F. R. Naka, AF 19(604)-5200, 22 Dec 59, (24:6), Unclassified, AD 241 994.

Anomalous overwater, short-range, low-altitude returns observed on coastal L-band radars were investigated and identified as being caused almost entirely by birds, rather than sea clutter, atmospheric inhomogeneities, or other possible origins. The technique of investigation is discussed, and the distribution, density, and temporal variations of the targets are described. A sea gull is said to be approximated by a quart of conducting fluid shaped roughly like a cone (the nose-on cross-section is appreciably greater than the tail-on), and having a cross-section of roughly 0.01 m^2 at 1300 Mc. An improved sensitivity time

5519 (Cont.)

control generator is described that makes gain a function of target range. This device discriminates against the bird returns on the basis of their cross-section, which is less than that of the desired aircraft targets, and (when properly adjusted for the site) allows nearly all bird returns to be removed from the PPI without loss of desired targets.

5520 Group Report 47-38, "The Scattering Matrix: Polarization, Power and Periodic Bodies from the Viewpoint of Matrix Theory," J. J. Mikulski, AF 19(604)-5200, 1 Mar 60, (-:6), Unclassified, AD 235 249.

(BD-4403) The solution of scattering problems leads to description of the field quantities in terms of vectors, dependent on space and time. This description is suited to matrix theory and, by the interrelation of space and time, to other than the goemetrical orthogonal system. The concept of a periodic scattering matrix, (and the physical source of it, the periodic body) as one which satisfies $A(t + n\tau) = A(t)$, n an integer, and its subsequent decomposition are discussed. The usefulness and meaning of this decomposition are presented and postulated as a means of detecting the presence of a periodic body in space and measuring its period.

5521 Group Report 64G-4, "Computer Programs for Processing Signals Received in Radar Astronomy Experiments," P. L. Fleck, Jr. and T. J. Goblick, Jr., AF 19(628)-500, 16 Aug 63, (28:5), Unclassified, AD 419 091.

A computer program is discussed for analysis of data from the Venus radar-reflection studies conducted at Lincoln Laboratory. The basic radar experiment is described, and operations necessary to maximize the signal-to-noise ratio of the echo are treated. Actual program features utilizing mainly FORTRAN and the IBM 7090 system are shown. (See also Abstract 5510.)

5522 Group Report 65G-8 (ESD-TDR-63-665), "Average Scattering Cross Section of Randomly-Oriented Dipoles," M. Check and B. Reiffen, AF 19(628)-500, 30 Dec 63, (16:3), Unclassified, AD 427 756.

An analytical approximation method for the bistatic cross-section of resonant half-wave and full-wave dipoles is presented. The calculations were accomplished by a Monte Carlo method estimated to be accurate to within a few percent. Cross-sections were calculated for various combinations of polarizations of transmitting and receiving antennas. Results appeared to be in agreement with certain results in the literature.

5523 Group Report 1964-2, "The Angular Resolution of Multiple Targets," J. R. Sklar and F. C. Schweppe, 14 Jan 64, (20:3), Unclassified, AD 430 185.

A two-dimensional radar model is used to investigate the amount of angular information inherent in a received signal. Bounds on the minimum obtainable angular accuracies are derived for the one- and two-target cases, using the Cramer-Rao inequality. Limited results are cited for the problem of deciding the number of targets present. For linear media and fixed aperture size, the degradation due to target number uncertainties is small until target separations become less than one beamwidth, where the degradation is severe.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, LINCOLN LABORATORY (CONT.)

5524 Group Report 1964-3, "Radar Backscatter from Some Low Cross-Section Shapes," A. F. Smith, 16 Jan 64, (32:7), Unclassified, AD 431 780.

Four axisymmetric shapes were investigated in hopes of finding a geometry showing reduced backscatter compared to the cone-sphere. All the shapes were minor variations from the basic cone-sphere. Three geometries were designed to reduce the travelling-wave return; the fourth was designed to determine the effect of the creeping-wave return. Metallic models were made and their radar cross-sections measured at frequencies from 4.8 to 35 Gc. No significant improvement was noted over the cone-sphere. It is suggested that creeping-wave return dominated in this frequency region for all four geometries; hence, the three designed for suppressing travelling-wave return might be better than the cone-sphere at frequencies lower than those used in the tests.

5525 Group Report 1964-14 (ESD-TDR-64-36), "Electromagnetic Backscattering Cross Section of a Circular Cylindrical Section," S. L. Borison, AF 19(628)-500, ARPA Order 498, 18 Feb 64, (33:7), Unclassified, AD 433 714.

The electromagnetic backscatter cross-section of a perfectly conducting circular cylindrical section is expressed in the Kirchhoff approximation. The cross-section for incidence at an arbitrary angle in either a longitudinal or a transverse plane is related to a geometrical structure integral. Using methods of contour deformation, this integral is approximated for the case of linear dimensions large compared to λ. Comparison of the cross-section with that of the equivalent flat plate (equal aperture) indicates that the central lobe of the flat plate is reduced by the factor $\lambda/8R \sin^2 \psi$; however, the angular width in the transverse plane is increased to approximately 2ψ. (R = radius of curvature; ψ = aperture half-angle.) Typical values of R and ψ are chosen for calculation and the results are presented pictorially.

5526 Group Report 1964-16 (ESD-TDR-64-43), "Cross-Section Measurements of the Echo II Satellite by the Millstone L-Band Radar," R. F. Julian and D. P. Hynek, AF 19(628)-500, 7 Apr 64, (8:0), Unclassified, AD 602 751.

Discussion of Echo II cross-section data measured at a frequency of 1295 Mc during the early revolutions of the satellite. Echo II displayed a very irregular cross-section pattern throughout the period covered by this report. No significant change was observed from run to run, except perhaps for larger and more frequent fades during the last passes; fades on the order of 10 dB were common, and 20 dB was frequently recorded. Estimated average cross-section during these observations was about one-half the theoretical 1330 m^2.

5527 Group Report 1964-29, "A Study of Radar Clutter in TRADEX," G. R. Curry, 25 May 64, (28:10), Unclassified, AD 441 068.

Clutter was measured with the TRADEX radar at UHF and L-band and found to be due to returns from clouds and from the sea. Sea clutter predominates at ranges less than 13 nmi, values of σ° of -100 dB being typical at both frequencies. Coherent scattering from clouds is suggested by the observed frequency independence of the cloud return. Values of cloud cross-section per unit volume are given; below 15,000-ft altitude, values of -140 dB (reference m^{-1}) are typical at both frequencies. A few Doppler spectra of the clutter are graphed.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, LINCOLN LABORATORY (CONT.)

5528 Group Report 1964-33 (ESD-TDR-64-341), "Probability Density for the Radar Cross Section of One or More Randomly-Oriented Dipoles," S. L. Borison, AF 19(628)-500, ARPA Order 498, 22 Jun 64, (20:7), Unclassified, AD 442 679.

Electromagnetic scattering from low-density, randomly-oriented chaff was examined and exact integral expressions derived for the probability density $P_N(\sigma)$ of the radar cross-section for one or more dipoles. Using an approximate expression for the angular dependence of cross-section, the density for one dipole is found to be a simple analytic expression. For two dipoles, numerical integrations were performed. It is concluded that the Rayleigh density is a good approximation for $N > 1$ if σ is at least greater than $\sigma_{avg} = N\sigma_o/5$, where σ_o is the peak cross-section of a single dipole. An appendix develops a mathematical expression for the probability density of the cross-polarized radar cross-section of a randomly oriented dipole. Probability densities are plotted for two randomly oriented and randomly separated dipoles, and for the cross-polarized radar cross-section of a randomly oriented dipole. The study was made to provide a better estimate of the effect of chaff on radars with high spatial resolution.

5529 Group Report 1964-61 (ESD-TDR-64-571), "Random Scatter Channels," E. J. Kelly, Jr., AF 19(628)-500, ARPA Order 512, 4 Nov 64, (47:0), Unclassified, AD 451 756.

Study of electromagnetic scattering from a region of space illuminated by two antenna beams, including scattering in which the perturbation of free-space conditions responsible for the scattering is complicated and amenable to a statistical treatment. Included are communications via tropospheric scatter or orbiting dipoles (West Ford), and the theory of radar return from a turbulent ionized gas or from a collection of many metallic scatterers.

Both continuous and discrete scattering media are treated. It is assumed that a macroscopic description of the continuous medium is valid, and its response is treated by electric and magnetic susceptibility functions. The discrete medium is assumed to comprise a random collection of small, perfectly conducting scatterers; the medium response is expressed in terms of the electric and magnetic polarizability tensors of each scatterer and a generalized number density. The report is highly theoretical, and the results are not applied to practical problems for illustration purposes.

5530 Group Report 1964-65 (ESD-TDR-64-580), "Draft Program Description for Radar and Radiometric Lunar Surface Studies," P. B. Sebring, Editor, AF 19(628)-500, 20 Nov 64, (45:14), Unclassified, AD 609 384.

Brief description of the characteristics of several Lincoln Laboratory radar astronomy facilities, including Millstone Radar, Haystack Radar, and the 28-ft, 8.6-mm facility. Using these facilities and other equipment, a series of experiments which would yield information about the lunar surface is outlined. These experiments include mapping studies, polarization studies, determination of temperature vs. lunar phase, and laser radar probing. Both radar and radiometric techniques are proposed for data collection. Actual data presented is confined to 5 pages on cross-sections and scattering behavior of the moon.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, LINCOLN LABORATORY (CONT.)

5531 Meeting Speech 423, "Scattering from Plasma Cylinders with Radial Variations in Electron Density," C. M. deRidder and S. Edelberg, [1962], (56:7), Unclassified, AD 400 947.

The amplitude and phase of the forward scattered and backscattered electromagnetic fields generated by a plane wave impinging upon a plasma cylinder were computed using an IBM 7090 computer. Cylinder end-effects and axial variation in the plasma are neglected, with computations made for three monotonic radial distributions in electron density which peak on the cylinder axis. They were: a quadratic polynomial, and two sixth-degree polynomials, one of which allows electron density to approach the cylinder surface with zero slope. Peak value of the density was varied from overdense to underdense. Results were compared with those for the homogeneous cylinder. Cylinders whose radii may be as large as 4λ were investigated. Also described is the use of these cylinder results to interpret data from transverse microwave horn experiments run during hypervelocity ballistic-range firings. Complications in interpretation caused by radial variations are discussed, as are effects of the radial variations on radar return.

Note: This is a preprint of a symposium paper, see Abstract 8564J.

5532 Lincoln Manual 54 (ESD-TDR-64-50), "TRADEX Data Evaluation," AF 19(628)-500, ARPA Order 166, 11 Mar 64, Unclassified, AD 443 423.

(BD-7417) Presentation of information necessary for interpretation and evaluation of TRADEX radar data. The appendices contain calculations of radar sensitivity, the derivation of the equations employed to calculate radar cross-section, a discussion of factors relating to the polarization of transmitted and received signals, and a résumé of sea and cloud clutter observations made by TRADEX.

5533 Project Report PA-6, "Curves of Transmission and Reflection of an Electromagnetic Wave by a Plane, Uniform Plasma Slab," J. Rheinstein, AF 19(604)-7400, 12 Feb 62 (revised 23 Mar 62), Unclassified.

(BD-2959) Presentation of a set of curves illustrating the transmission of a plane wave through a plane, uniform plasma slab, and reflection from the slab, as a function of the normalized plasma frequency. Figures are given for several slab thicknesses, and the normalized collision frequency is employed as a parameter.

5534 Project Report PA-16, Revision 1 (BMRS), "Survey of Radar Reflectivity Ranges," P. C. Fritsch, AF 19(628)-500, 2 Jan 63, (7:0), Unclassified, AD 420 787.

Reports the results of a survey of all non-government agencies known to have radar-reflectivity measurement facilities. The cooperating organizations were asked to describe their capabilities as of the survey date, December 1962, as well as those anticipated as of March and December 1963. Sixteen agencies responded to the mailed questionnaire; the information received is presented in tabular format.

Note: A similar survey made by Army Missile Command is presented in their Report RE-TR-63-4; see Confidential volume, Volume VIII.

5535 Project Report PA-37 (BMRS), "Some Experimental Results of Backscatter from Thin Wires 2.5 to 4.6 Wavelengths Long," J. Rheinstein, AF 19(628)-500, 29 Aug 63, (9:4), Unclassified, AD 418 671.

5535 (Cont.)

Experiments were conducted on the scattering properties and statistics of thin wires 2.5λ to 4.6λ long at 35.03 Gc. A total of 20 cross-section patterns were taken, and the peak cross-sections at normal incidence for these measurements are tabulated and plotted. Also included are distribution functions for the cross-section, assuming a spherical random ensemble or planar random ensemble.

5536 Project Report PA-43 (BMRS), "Two Computer Programs for Simulating the Radar Cross-Section History of a Ballistic Body," B. Nanni and G. I. Tabasky, AF 19(628)-500, 25 Jun 64, (18:-), Unclassified.

(BD-8406) Description of a set of two programs to compute the bare-body radar cross-section history of a re-entering vehicle.

5537 Project Report RP-5 (Re-entry Physics), "Calibrated Radar Amplitudes for Trailblazer Im," E. O. Gronroos and J. C. Howard, AF 19(628)-500, ARPA Order 13, 24 Apr 64, (24:18), Unclassified, AD 447 830.

Calibrated radar-amplitude records were obtained at S-band, UHF, and X-band during the flight of a Trailblazer I vehicle, a six-stage, solid-fuel rocket. Taken in real time and providing an immediate continuous monitor of vehicle and system performance, these records can be used to compute actual received power, system signal-to-noise ratio on each stage, and radar cross-section characteristics.

5538 "Certain Questions of the Physics of the Ionosphere," Ia. L. Al'pert, AF 19(122)-458, Oct 57, (49:19), Unclassified, AD 133 748.

This document is a compilation of short theoretical studies on the following topics: (1) the effective cross-section of ionospheric scattering; (2) scattering during vertical probing of ionosphere; (3) scatter propagation at wavelengths of 2 to 20 m; and (4) turbulence of the ionosphere. The translation is good.
Note: This is a translation of a journal article (see Abstract 8381J).

5539 "Bibliography of Technical Publications," AF 19(628)-500, 15 May 63, (70:600), Unclassified.

Listing of over 600 classified and unclassified reports issued by Lincoln Laboratory between 1951 and 1963, arranged according to type of report. An author index is included. Some reports are pertinent to radar reflectivity. (Unclassified journal articles, meeting speeches, and group reports are listed only in another bibliography, see following abstract.)

5540 ESD-TDR-64-340, "Unclassified Publications of Lincoln Laboratory," AF 19(628)-500, 15 Mar 64, (210:2000), Unclassified, AD 607 539.

A cumulative listing of over 2000 unclassified reports on many topics published by Lincoln Laboratory since 1951. Reports are arranged according to type, including journal articles. Bibliographic data indicate title, author, date, and DDC number only; author and subject indices are included. Some reports are pertinent to radar reflectivity and related topics. (Classified reports are listed only in another bibliography, see preceding abstract.)

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, RESEARCH LABORATORY OF ELECTRONICS

5541 Technical Report 382, "The Reflection of Radio Waves from an Irregular Ionosphere," M. L. V. Pitteway, DA 36-039 SC-78108, 8 Nov 60, (26:15), Unclassified, AD 264 721.

A theoretical analysis of two-dimensional scattering by a thin layer of irregularities distributed both vertically and horizontally in the ionosphere. Previous solutions of the wave equation for a horizontally stratified ionosphere are extended to include strong scattering; the results are applied to scattering by (1) a diffraction grating, buried in a medium of refractive index μ, and (2) thin layers of irregularities in the medium. Results are compared with the ray theory of scattering.

MATHER AIR FORCE BASE, SENIOR OBSERVER SECTION

5542 "Considerations for Installing Radar Reflectors at Mather Air Force Base," K. R. Stow, 14 Mar 54, (17:6), Unclassified, AD 147 597.

An internal report concerned with problems associated with the installation of radar corner reflectors at Mather Air Force Base. The only material of general interest is a 5-page section on the elements of corner-reflector design, and that merely summarizes basic material available in many other sources.

MCGILL UNIVERSITY (CANADA)

5543 Scientific Report MW-27 (AFCRC-TN-58-413), "Studies of Alberta Hailstorms, 1957," R. H. Douglas, W. Hitschfeld, K. L. S. Gunn, and J. S. Marshall, AF 19(604)-2065, 24 May 58, (79:5), Unclassified, AD 152 578.

This report is primarily concerned with tne basic physics of the hailstorm. The 83 storms discussed were observed from the surface and with a Decca Type DC-19 3.2-cm radar. It is shown that the probability of hail increases with echo-top height. Since an upsurge of echo top was often followed by hail, it is suggested that strong updrafts may be required for hail formation.

5544 Scientific Report MW-32 (AFCRL-TN-60-658), "Weather-Radar Attenuation Estimates from Raingauge Statistics," P. M. Hamilton and J. S. Marshall, AF 19(604)-2065, Jan 61, (65:11), Unclassified, AD 250 196.

This statistical study of the attenuation along a radar path at wavelengths of 3 cm and 5.7 cm is based on rainfall rates observed at a point in the path of the storms. It was found that attenuation increases greatly with intensity of target rain. Most attenuation is attributed to heavy rain in or very close to the target shower. Distortion due to rain is discussed briefly; it is suggested that this could be avoided by using a wavelength of 5.7 cm, while truly quantitative operation demands 10 cm. Graphs of attenuation vs. rainfall rate and range are presented, and an appendix includes attenuation profiles, at 3- and 5.7-cm wavelengths, of 21 storms with rainfall rates in excess of 40 mm/hr.

5545 Scientific Report MW-38 (AFCRL-65-10), "Two Studies of Convection," R. C. Srivastava and C. D. Henry, AF 19(628)-249, Oct 64, (130:82), Unclassified, AD 616 094.

This report comprises two separate papers, the first of which, "A Model of Convection with Entrainment and Precipitation," by R. C. Srivastava, contains no radar-reflectivity information. The other, "High Radar Echoes from Alberta Thunderstorms," by C. D. Henry (22:19), is an abridgment of the author's M.Sc. thesis at McGill University. The aim of this study was twofold: to determine some

MCGILL UNIVERSITY (CANADA) (CONT.)

5545 (Cont.)

of the characteristics of tall Alberta storms, such as geographical locations, manner of growth, tropopause penetration, and atmospheric temperature and moisture conditions, and to compare actual echo-top heights to cloud heights predicted by simple thermodynamic parcel theory. Radar data on 112 of the highest and most severe Alberta thunderstorms were extracted from photographic records obtained with a 3.2-cm radar. The actual echo heights agreed quite well with those predicted by parcel theory.

5546 Scientific Report MW-39; SR-1 (AFCRL-64-1006), "Interpretation of the Fluctuating Echo from Randomly Distributed Scatterers: Part 3," P. L. Smith, Jr., AF 19(628)-2489, Dec 64, (78:-), Unclassified, AD 614 658 (DDC reference only).

(DDC) The problem of estimating the long-term mean echo intensity by examining only a small number of echoes is treated. The solution to the problem is obtained as a probability distribution of the long-term mean echo intensity. This distribution becomes narrower and more sharply peaked as the number of independent echoes measured increases. The exact form of the distribution depends on the assumed a priori probability distribution; however, the dependence becomes negligible when the number of echoes is sufficiently large. Averaging echo intensities is the optimum method of processing the echoes; averaging intensity levels or amplitudes is less satisfactory. However, the loss of precision when intensity levels are averaged is small and may be offset by other advantages of the logarithmic scale. Measuring only the intensity level of the maximum echo gives better results than averaging when the number of echoes is small, and somewhat poorer results when the number is large.

METEOROLOGICAL RESEARCH COMMITTEE, AIR MINISTRY (GREAT BRITAIN)

5547 Report MRP-1068; SC III/241, "The Origin of Radar 'Angels'," W. G. Harper, 28 Aug 57, (19:15), Unclassified, AD 216 170.

For this investigation, a 10-cm radar and a telescope were used to observe radar [point] angels and their sources; the results attribute angel echoes to migratory bird formations. (Ed: The suggestion that there is no reason to invoke any other mechanism than birds to explain angel echoes is too sweeping. The occurrence of return from atmospheric refractive-index gradients and other non-precipitation targets is well substantiated, for both point and distributed returns.)

MICHIGAN STATE UNIVERSITY

5548 Technical Report 1, "Minimization of Back Scattering of a Cylinder with a Moderate Radius by Loading Method," K-M Chen, Subcontract from University of Michigan, Radiation Lab under AF 33(615)-1656, Dec 64, (33:8), Unclassified, AD 454 928.

Presentation of a theory on minimizing backscatter from a cylinder with a moderate radius by the loading method. The dimensions of the cylinder are such that $ka \leq 1$ and $\pi/4 \leq kh \leq 2\pi$, where a is the radius and h the half-length of the cylinder. The cylinder is illuminated by a plane wave with either electric or magnetic vector parallel to the cylinder axis. A slot is inserted at the center of the cylinder to minimize backscattering. Surface current induced on the loaded cylinder is explicitly obtained, the backscattered field is calculated, and the optimum loading which leads to zero backscattering from a cylinder is determined.

MIDWEST RESEARCH INSTITUTE

5549 Final Technical Report, 19 Dec 1961-18 Dec 1962, "Research Studies Related to Mapping, Geodesy and Position Determination," R. S. Brown and E. J. Martin, Jr., DA 44-009 ENG-3769, 14 Jan 63, (75:-), Unclassified, AD 402 602.

This report documents an investigation into the feasibility of measuring the index-of-refraction profile along some path in the atmosphere by measuring the transitory reflections from a short pulse of radio energy traversing the profile. Theory is developed and it is shown that the desired information would in principle be obtainable from measurements of reflected signals. Experiments are outlined to check the theory; the frequency contemplated is 35 Gc or higher.

MITRE CORPORATION

5550 Technical Series Report 2 (ESD-TDR-62-151), "Summary of Maximum Theoretical Accuracy of Radar Measurements," R. Manasse, AF 33(600)-39852, 1 Apr 60, (-:7), Unclassified, AD 287 563.

(BD-4353) The parameters of a radar target determine how the transmitted waveform is modified by the target to produce a reflected waveform. The target is characterized by such parameters as cross-section, range, radial velocity, angular position, and angular rate and radial acceleration. Once the target has been detected, the signal energy received across the antenna aperture may be processed to form an estimate of the target parameters. It is assumed that the received waveform has been corrupted by additive white Gaussian noise. An optimum estimation method for measuring target parameters is the method of maximum likelihood. This method can be implemented in the case of additive white Gaussian noise by selecting the peak output from a set of filters where each filter is matched to a set of parameter values. There is one filter for each essentially different combination of parameter values. The accuracy available from the maximum likelihood method depends not only on the relative strength of signal and noise at the receiver, but also on the shape of the antenna aperture and the character of the transmitted waveform.

MOTOROLA, INC.

5551 Report RL-3835-4 (Quarterly Report 4), "Radio Transmission Loss Determination by Radar Techniques," S. R. Bradshaw, P. L. Cassell, D. E. Moore, and R. W. Steinmetz, DA 36-039 SC-74949, Nov 58, (95:2), Unclassified, AD 208 246.

Study of methods for using radar backscatter return to rapidly establish efficient short-distance radio communications. Resultant data include photographs of PPI returns and terrain, and a table of terrain loss measurements. Terrain loss was considered to be the difference between measured path loss and free-space loss; approximately 28 different paths were investigated at frequencies of 1310, 2450, 4000, and 8200 Mc. The average terrain loss per mile for wooded farmland was about 4.5 dB per mile at L-band, and it was found that the received signal could often be maximized by aiming the antenna at the tree tops. Conclusions are: (1) terrain loss for wooded paths is extremely high; (2) good correlation exists between map features and radar backscatter returns; and (3) terrain loss results are consistent from path to path as a function of frequency.

Ed: Photographs in the DDC-reproduced document are of poor quality, making comparison between map features and backscatter return difficult.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

5552 Technical Note D-115, "Predicted Characteristics of an Inflatable Aluminized-Plastic Spherical Earth Satellite with Regard to Temperature, Visibility, Reflection of Radar Waves, and Protection from Ultraviolet Radiation," G. P. Wood and A. F. Carter, Oct 59, (26:21), Unclassified, AD 227 295.

A design study was made to determine the feasibility of using a hollow aluminized-plastic sphere, in a terrestrial orbit at an altitude of approximately 1000 miles, such that it would: (1) be easily visible to the naked eye; (2) be a good reflector of radar waves; (3) be protected from deterioration of the plastic by ultraviolet radiation; and (4) assume acceptable extremes of temperature. It was found that these radiation requirements would probably be met by a sphere constructed of $\frac{1}{4}$-mil Mylar which has a diameter of 100 ft and a vapor-deposited aluminum coating 2200 angstroms thick. (See also next abstract.)

5553 Technical Note D-664, "Microwave Reflectivity of Deposited Aluminum Films for Passive Relay Communications," W. F. Cuddihy and L. H. Shreve, Feb 61, (22:4), Unclassified, AD 250 544.

Reflectivity measurements from 400 Mc to 10 Gc on $\frac{1}{2}$-mil Mylar film coated with 2200 angstroms thick aluminum; the results showed this material to be a very good reflector of radio waves. The measurements were taken under conditions of stress and temperature that might be encountered by a communications satellite, such as Project Echo. Very little deterioration of the high reflectivity was noted. Construction seams and packaging effects also caused very little change in reflectivity; however, under conditions of severe temperature cycling, some flaking of the aluminum film occurred, which decreased reflectivity. (See also preceding abstract.)

5554 Technical Translation F-68, "Radar Observations of Meteors According to the International Geophysical Year Program," B. L. Kashcheyev, Aug 61, (20:8), Unclassified, AD 261 704.

Preliminary results are reported for the first 12 months of the International Geophysical Year. Histograms show diurnal distributions of meteor activity for several locations and frequencies; other plots show velocity distributions. A section on properties of the atmosphere at 80-100 km altitude comprises: the relation of diffusion coefficient and homogeneous atmosphere height; the determination of meteor-trail drift velocity; and the variation of atmospheric pressure. A good translation.

Note: This is a translation of: "Radiolokatsionnyye nablyudeniya meteorov po programme Mezhdunarodnovo geofizicheskovo goda," V. Section of the IGY Program (Investigation of Ionosphere and Meteors), No. 2, 40-53, (1960).

NATIONAL BUREAU OF STANDARDS

5555 Report 5010, "The Measurement of Ionospheric Absorption Using Ionosondes," K. Davies, 22 Aug 56, (24:0), Unclassified, AD 116 375.

Sweep-frequency ionosondes were adapted to the determination of ionospheric absorption of radio waves on a fixed frequency of 2.3 Mc, by measuring changes in amplitude of the once-reflected ionosphere signal. Discussed are theory, equipment, measurement techniques, data processing, and accuracy.

NATIONAL BUREAU OF STANDARDS (CONT.)

5556 Report 6779, "Model Ionosphere Reflection and Transmission Coefficients for a Diffuse Electron-ion Plasma Boundary," J. R. Johler and J. D. Harper, Jr., AF 30(602)-2488, 1 Jun 61, Unclassified.

(BD-2957) A theoretical model plasma which can be fitted to almost any measured electron density-altitude, collision frequency-altitude profiles is employed, together with available geophysical data on the ionosphere, to evaluate reflections and transmissions during disturbed-blackout and quiescent propagation conditions. Reflections and transmissions in the ionosphere are determined rigorously with the aid of classical magneto-ionic theory. Complex indexes of refraction of the medium are deduced, and coupling in the plasma between ordinary and extraordinary, upgoing and downgoing modes of propagation is investigated. The corresponding reflection and transmission coefficients are then calculated, and certain phenomena, which can be expected as a result of the action of a solar disturbance on the reflection process, are predicted.

Although the electron-ion redistribution as a result of the action of a disturbance of solar origin on the lower ionosphere influences reflected and transmitted waves at low frequencies in a complicated manner, the so-called total blackout phenomena exhibited by high-frequency waves does not seem to exist for the plasma profiles investigated with classical magneto-ionic theory.

5557 RADC-TDR-63-388, "RADC Propagation Studies--Task 1. Backscatter Studies of Ionospheric Irregularities," L. H. Tveten, AF 30(602)-2488, Nov 63, (20:3), Unclassified, AD 424 988.

Describes techniques and results of HF backscatter experiments designed to study irregularities and short-term perturbations in the ionosphere. Techniques used include: (1) fixed-frequency, amplitude-range-time observations made with a wide antenna beam; (2) sweep-frequency, amplitude-range observations made with a wide antenna beam; and (3) fixed-frequency, narrow-beam-scan, amplitude-range-azimuth observations. A brief discussion of backscatter fading characteristics is included. It is concluded that the above-stated techniques are valuable for observing large areas of the ionosphere at a given time.

5558 Report 7211, "Reflection of Electromagnetic Waves from Inhomogeneous Media with Special Profiles," J. R. Wait, PRO-61-568, 15 Nov 61, Unclassified.

Note: This report was not obtained.

5559 Report 7212 (Scientific Report 16; AFCRL-993), "Approximate Methods for Treating Reflections from Inhomogeneous Media," J. R. Wait, PRO-61-568, 15 Nov 61, (36:15), Unclassified, AD 273 462.

Problems of wave reflection from inhomogeneous media tend to be intransigent and require use of some approximation technique; this report provides a good summary of the various methods that are available. The discussion begins with the conventional WKB method and proceeds through several generalizations and variations on that technique for use with "slowly varying" parameters. Several forms of the "phase integral method" are discussed in connection with media for which the more conventional forms of the WKB approximation are unsuited. Practical examples of application to ionospheric propagation are included.

Note: This report also appears as a chapter in a book, Electromagnetic Waves in Stratified Media.

NAVAL AIR DEVELOPMENT CENTER

5560 Final Report (NADC-ED-6366), "Flight Test Results and Radar Augmentation Requirements for DASH (QH-50C)," E. G. Olson, 21 Jan 64, (29:-), Unclassified, AD 429 333L. (All requests require approval of Bureau of Naval Weapons, Navy Department, Washington 25, D. C.)

(DDC) In order to formulate radar augmentation requirements for DASH (QH-50C), flight tests were conducted using radar beacons and traveling-wave tube augmentation systems installed in a piloted QH-50C. Flights were made at altitudes of 500 ft and below to a range of 30 nmi from a ship equipped with AN/SPS-10 radar. It is concluded that a radar beacon having a minimum sensitivity of -51 dBm and a minimum radiated power of 80 watts is required to assure reliable and consistent tracking to 30 nmi. A rudimentary requirement specification for such a beacon is presented.

NAVAL MISSILE CENTER

5561 Miscellaneous Publication NMC-MP-64-7, "Tables and Curves for Radar Range Calculations," L. L. Rogers, 2 Sep 64, (12:-), Unclassified, AD 447 432.

Graphs and tables show radar detection range (relative to that of a one-square-meter target) vs. cross-section in square meters and vs. radar power change in dB.

NAVAL ORDNANCE LABORATORY, CORONA

5562 NAVWEPS Report 7180, Part 1, "Backscatter Measurements from Targets at X-Band Frequency. Part 1: Test Equipment, Procedures, and Results," A. N. Hilkevitch and A. J. Henderson, 15 Jul 61, (73:5), Unclassified, AD 263 434.

Microwave backscatter measurements were taken at X-band on the nosecone, tail section, and wing of an F9F-2 fighter aircraft, and on a complete Ryan KDA drone. The instrumentation and facilities, data-collection methods, and data-analysis techniques are described in this report. The test results, which are applicable to both fixed and scanning antennas, showed that signal return from all targets varies greatly for small changes in antenna aspect angle and target azimuth. The average cross-polarization ratio on the Ryan KDA drone was 23.6 dB. (The theory and construction of the bistatic-measurement system are described in Part 2.)

NAVAL RADIOLOGICAL DEFENSE LABORATORY

5563 USNRDL-TR-253, "A Wind-Measuring System for Tactical Fallout Prediction," A. D. Anderson and W. E. Strope, 3 Sep 58, (20:17), Unclassified, AD 221 532.

Proposal for a wind-measuring system which would use radar to measure the drift of falling passive targets delivered to required locations in the atmosphere by rockets or gun projectiles. This application is based on use of the Loki rocket, chaff or other radar reflector, and existing fire-control radars. Possible development is discussed of an optimum system which could provide accurate wind data within 10 minutes after the rocket is fired. A tactical situation must be analyzed to fully determine the requirements to be met by the proposed tactical wind-measuring system.

NAVAL RESEARCH LABORATORY

5564 Report 4694, "A Target Simulator," A. J. Stecca, N. V. O'Neal, and J. J. Freeman, Feb 56, Unclassified.

Note: This report was not obtained.

5565 Report 4770, "Target Noise Simulator-Closed-Loop Tracking," A. J. Stecca and N. V. O'Neal, Jul 56, Unclassified.

Note: This report was not obtained.

5566 Report 4902, "Characteristics of Radar Sea Clutter. Part 1. Persistent Target-Like Echoes in Sea Clutter," F. C. Macdonald, 19 Mar 57, (9:3), Unclassified, AD 126 745.

The X-, S-, and L-band radars in the NRL Flying Laboratory measured sea clutter off Bermuda in October 1955 and January 1956 transmitting either vertical or horizontal polarization and generally with both polarizations received and recorded in separate channels. This report deals with one phase of the measuring program--spikyness, the tendency of sea clutter to resolve into individual, target-like echoes. It is found that sea clutter in A-scope photographs appears more spiky, other parameters being equal, for horizontal rather than for vertical polarization; for radars looking up- or downwind rather than for crosswind; for low radar frequencies rather than for high; and for near-grazing rather than for steep incidence angles. These findings are compared with qualitative predictions based on picturing the illumination of the important higher waves as composed of a direct ray and an indirect, possibly interfering, ray reflected by the approximately horizontal sea surface. In general, the findings agree with the qualitative predictions.

5567 Report 4976, "Spectral Bandwidth of Backscatter Signals," G. K. Jensen and C. L. Uniacke, 21 Aug 57, (12:8), Unclassified, AD 473 175.

Development of a system to measure the spectra of radar signals backscattered via the ionosphere. A study of backscatter signals conducted at 26.6 Mc over a four-month period shows that the spread in backscatter spectrum due to all causes does not exceed $\pm$ 4.0 cps. Narrow-band rejection filters based on this information were constructed and found to eliminate very satisfactorily the backscatter signals in a receiving system. Several factors which could influence backscatter bandwidth were investigated. Wave height in the North Atlantic area showed correlation with backscatter bandwidth, higher sea states causing bandwidth to increase. The quality of radio propagation for the North Atlantic area was also compared with the backscatter bandwidths with negative results.

5568 Report 5218, "Characteristics of Radar Sea Clutter. Observations at 220 Mc," W. S. Ament, J. A. Burkett, F. C. Macdonald, and D. L. Ringwalt, 19 Nov 58, (15:4), Unclassified, AD 206 590.

Sea-clutter echo power and fluctuation characteristics were measured with a 220-Mc horizontally polarized radar mounted in a blimp at altitudes of 500 and 3000 ft. For well-developed sea conditions, with surface winds varying from 0 to 12 knots, there was little variation in $\sigma°$ as function of azimuth. As a function of grazing angle θ, $\sigma°$ varied as θ^4 over 1° to 14°, the range of the observations. Clutter fluctuation rates were generally higher when the radar looked crosswind than when it looked up or downwind. Crosswind echoes often contained well-defined periodic fluctuations at rates corresponding to twice the period of a classical

NAVAL RESEARCH LABORATORY (CONT.)

5568 (Cont.)

ocean wave of half the radar's wavelength. Upwind echoes often fluctuated at high rates corresponding to the beat frequency between an echo from a stationary target and an echo from a wave crest moving at the dominant oceanographic crest speed. About seventeen figures show observed values of σ° vs. incidence angle and sweep-to-sweep correlations.

5569 Report 5430, "Radar Target Angular Scintillation in Tracking and Guidance Systems Based on Echo Signal Phase Front Distortion," D. D. Howard, 23 Dec 59, (10:8), Unclassified, AD 231 537.

Noise in tracking-radar systems is comprised of fluctuations in signal amplitude and in apparent target direction; the latter is known as glint. This analysis shows that for the echo from a complex target (or group of targets), glint is a distortion of the phase front of the signal and may be visualized as a tilt of the phase front arriving at the receiver. Angular error in target location for a two-reflector target is demonstrated to be relatively small except when the phase angle between returns from the two components is near 180°; for angles close to 180° the error can be much greater than actual target separation. A complex target comprising a large number of point reflectors is next treated, and again it is demonstrated that angle noise is identical to phase-front tilt. The report concludes with a brief argument showing that in general any target-locating device essentially measures phase front and hence will be affected by glint, and a comment on the identity of radar glint with the distortion in an FM receiver caused by reception from two sources.

5570 Report 5615, "The Distribution of Reflecting Cross Sections of Satellites," R. E. Brescia and R. R. Zirm, 25 May 61, (10:3), Unclassified, AD 259 990.

The bistatic radar cross-section of five artificial satellites was measured with the Navy's space surveillance sensors. The statistical variation of these quantities must be known in order to calculate probability of detection, and is also of value in forming estimates of target geometry, size, and motion. It was determined that the long-term fluctuation in apparent size of these objects follows a lognormal distribution with a standard deviation probably dependent on object geometry and motion. For symmetrical, stabilized objects the standard deviation is approximately 5 dB, while for a cylindrical tumbling object it was found to be about 7 dB. Confidence intervals for cross-section are given in terms of deviation from the log mean of the calculated values of area.

5571 Report 5656, "Doppler Spectral Characteristics of Aircraft Radar Targets at S-Band," R. E. Gardner, 3 Aug 61, (34:7), Unclassified, AD 263 478.

A good discussion on the nature of Doppler frequency spectra of aircraft returns. Although based on measurements with an S-band pulse-Doppler system, the results are applicable to any Doppler radar system. Attention is focused on the spectra deriving from propeller motion, and from motion of compressor or turbine blades on turbojet aircraft. Simple theory is used to explain the major characteristics observed in the spectra. It is concluded that the Doppler spectrum from the rear of propellers resembles a sin x/x amplitude distribution, with main lobe typically 600 cps wide and spectral lines spaced by the blade modulation frequency. From the front, propellers give a Doppler return that contains frequency as well as amplitude modulation. The lines of this front return are grouped near the airframe Doppler frequency for small aspect angles, but spread over a greater portion of the spectrum below the airframe line at larger aspects.

NAVAL RESEARCH LABORATORY (CONT.)

5571 (Cont.)

An approaching turbojet shows sidebands around the airframe line due to the rotating compressor blades; the first lower sideband predominates and averages only 5 dB below the airframe line. Compressor modulation can be detected at aspects up to at least 60°. The report also discusses scintillation of the airframe line, and velocity-noise spectral density.

5572 Report 5701, "Measurements Using a Polarization Instrumentation Radar on Navigational Buoys," I. D. Olin and F. D. Queen, 21 Nov 61, (39:6), Unclassified, AD 268 727.

A specialized instrumentation radar was built for studying the polarization properties of targets, and tests were conducted on three standard types of radar navigational buoys (Coast Guard designations 8 x 26 (RR), 1st Class (RR), and 3rd Class (RR)). The radar, a modified X-band pulsed system, was capable of illuminating the target with any of four selected polarizations: vertical, horizontal, left circular, and right circular, and of receiving and recording the four reflected components simultaneously. Besides descriptions of the equipment and experiments, the report includes cumulative echo-area distributions for the three target types for various polarization combinations, and other test results. Appendices contain brief discussions of the theory behind the measurements.

It was found that transmission of vertical and horizontal polarization resulted in no observable depolarization of the returns. However, substantial depolarization resulted with use of circular transmission. Median values of measured cross-sections are summarized below.

	Median Cross-Section in Square Feet					
Buoy	VV	HH	RR	LL	LR	RL
8 x 26 (RR)	4000	5900	7300	2100	420	1750
1st Class (RR)	7200	13000	7000	9700	900	3600
3rd Class (RR)	700	300	100	200	150	370

5573 Report 5767, "Analysis of Matched-Filter Radar Multipath Returns at 435 Mc," J. M. Goodman, 17 Apr 62, (21:4), Unclassified, AD 275 296.

A statistical analysis was made of three-pulse echoes received from an aircraft target by a short-pulse radar as the result of multipath propagation. The first received pulse follows a direct path to and from the target; the second is the resultant of two components, one reaching the target by surface reflection and returning by the direct path, and the other following the same route in the opposite direction; the third travels both to and from the target by surface reflection. Recorded amplitudes of individual pulses were analyzed to determine their amplitude distribution, average value, standard deviation, power spectrum, and cross-correlation with the other two pulses. Observations of WV-2 and P2V aircraft as targets were made over water with an airborne 435-Mc matched-filter radar. Propeller modulation was noted at nose-on aspects.

5574 Report 6052, "Ocean Wave Profiling Radar System," C. M. Morrow, 21 Apr 64, (23:6), Unclassified, AD 602 293.

A qualitative description of an airborne oceanographic sensor designed for high-speed profile mapping of ocean-wave structure. The aircraft maintains level flight at low altitude, and instantaneous distance to a spot on the ocean surface

NAVAL RESEARCH LABORATORY (CONT.)

5574 (Cont.)

directly beneath is measured and continuously recorded on a roll chart, which therefore portrays a laterally compressed cross-section of the ocean surface along the flight track. Frequency modulation of a 9400-Mc CW microwave source is used to measure transmission delay by phase comparison of the demodulated return with the modulating reference signal. Wave heights can be resolved to less than 6 inches, over a dynamic range up to 50 ft, by making the radar-illuminated spot sufficiently small and transmission bandwidth sufficiently large. Multipath interference between reflecting wave facets within the beam is minimized by a sinusoidal FM output over a 4-percent bandwidth. It was concluded that this system is effective for rapidly surveying existing sea state.

5575 Report 6099, "Polarization Techniques and Components for Radar and Communication Systems," P. J. Allen and R. D. Tompkins, Jun 64, Unclassified.

Note: This report was not obtained.

5576 Memorandum Report 738, "Quantitative Measurements of Radar Echoes from Aircraft XIV. FJ-2," F. C. Macdonald and R. D. Shewbridge, 10 Sep 57, Unclassified.

Note: This report was not obtained.

5577 Memorandum Report 1046, "A Note on Measurement of Polarization Transformation Properties of Radar Targets," I. D. Olin, May 60, Unclassified.

Note: This report was not obtained.

5578 Memorandum Report 1082, "A System for the Dynamic Measurement of Radar Return Polarization," I. D. Olin, Apr 60, Unclassified.

Note: This report was not obtained.

5579 Memorandum Report 1085, "A Passive Means of Reflecting a Constant Wave Polarization of Arbitrary Selection," I. D. Olin, Aug 60, Unclassified.

Note: This report was not obtained.

5580 Memorandum Report 1086, "A Four-Component Polarization Resolver for Microwaves," P. J. Allen and I. D. Olin, Apr 60, Unclassified.

Note: This report was not obtained.

5581 Memorandum Report 1100, "The Evaluation of Radar Target Null Polarizations and Transform Properties," I. D. Olin, Oct 60, Unclassified.

Note: This report was not obtained.

5582 Memorandum Report 1368, "Radar Echoes from Ships," J. T. Ransone, Jr., W. T. Davis, and J. C. Daley, 30 Oct 62, (25:0), Unclassified, AD 474 135L. (U.S. Government agencies may obtain copies directly from DDC; others to Director, Naval Research Lab., Washington, D. C. 20390.)

Tracking and fixed-elevation runs were made with an airborne radar to measure the cross-section of ships. The radar operated at X-band with a pulse width of 0.3 μsec, a beamwidth of 5°, and vertical polarization. Vertical and horizontal returns were received and are referred to as VV and VH, respectively. Elevation

NAVAL RESEARCH LABORATORY (CONT.)

5582 (Cont.)

angles were from 5° to 90°, and various aspects were observed for a tanker and a YAGR picket ship. A 6-inch aluminum sphere was dropped from the aircraft and scanned 30° per second in elevation to obtain calibration data. Data are for received power at 10%, 50%, and 90% levels averaged over 1000 pulses (one second) for the ships; calibration data are averaged over 32 pulses. Plots are given of power levels vs. elevation angle for the tracking runs and vs. time for the fixed-elevation runs. Some data points are also shown for sea return on these plots.

Results indicate that these ships gave both VV and VH cross-sections greater than the sea up to angles of 55-60° from the horizontal for wave heights of about 3 to 4 ft. Stern and bow aspects gave smaller returns than beam or quarter aspects. Near vertical incidence, the contrast was such that the target could be detected on VH but not on VV; the increase in contrast was 10-15 dB.

Median values of cross-section for the YAGR on the beam were typically about 29-31 dBsm for elevation angles from 10° to 45° for VV, and 6-9 dBsm for VH. Quarter aspects gave about the same or somewhat higher values most of the time; bow and stern aspects typically had cross-sections 10 to 15 dB lower. The tanker gave beam-aspect VV cross-sections of about 35 dBsm for the same elevation angles, and VH cross-sections were about 23 dBsm. Elevation dependence of cross-section for these targets does not seem to be particularly strong over the range 5° to 55°, but some decrease with increasing angle seems apparent.

Note: Data in this report are given in terms of received power; another report presents the same information in terms of cross-section (see Abstract 5432).

5583 Memorandum Report 1430, "Radar Backscatter from a Conical Corner Reflector," R. D. Tompkins, Jun 63, Unclassified.

Note: This report was not obtained.

5584 Memorandum Report 1474, "The Radar Target Scattering Matrix in Linearly and Circularly Polarized Components for Target Aspect Changes Around the Line of Sight," H. A. Brown, Oct 63, (21:2), Unclassified, AD 453 174.

In this theoretical study, scattering equations are developed relating illuminating and backscattered waves for linearly and circularly polarized components in matrix forms adaptable to analog computation. The effect on the target scattering matrix of rotating a target about the line-of-sight is examined. Target matrices for a sphere and a flat plate at normal incidence, for a dihedral corner reflector, and for a dipole are treated as simple geometrical examples.

5585 "Report of NRL Progress," Aug 64, (50:-), Unclassified, AD 605 368.

This progress report includes a paper entitled "Radar Auroral Echoes," S. B. Rutiser (7:2), which discusses observations of field-aligned ionization in the aurora made with the 150-ft antenna at the Chesapeake Bay Annex. No other pertinent material is included.

Ed: Available DDC-reproduced copy of this document is nearly illegible.

NAVY ELECTRONICS LABORATORY

5586 DASA-1479, "Program for the Full-Wave Calculation of Reflection Coefficients in an Ionosphere Continuous in Electron Density and Collision Frequency," J. Fedor, L. Fedor, and E. E. Gossard, 1 Feb 64, (99:3), Unclassified, AD 451 223.

NAVY ELECTRONICS LABORATORY (CONT.)

5586 (Cont.)

Presents a program for the CDC 1604 computer to determine reflection coefficients in a continuous ionosphere digitized in arbitrarily small height increments, assuming arbitrary electron-density and collision frequency distribution. The output of the program is the magnitude of the reflection coefficient matrix and phase difference of the upgoing and downgoing waves read out at arbitrary height.

NAVY WEATHER RESEARCH FACILITY (NAVAL AIR STATION, NORFOLK)

5587 NWRF 12-0661-046, "Hurricane Reconnaissance with Airborne Radar," M. G. H. Ligda, Jun 61, (101:10), Unclassified, AD 263 930.

Written as a guide for the flight meteorologist, this manual is intended to provide general information about airborne radar weather reconnaissance. It contains a dissertation on the basic fundamentals of radar, a description of radar meteorology, a discussion of radarscope interpretation, an outline of a reconnaissance mission, and a section on hurricane observations.

NEW YORK UNIVERSITY, COURANT INSTITUTE OF MATHEMATICAL SCIENCES

5588 Research Report BR-27 (AFOSR-TN-58-749), "Transcendental Equations in Electromagnetic Theory," L. Kotin and W. Magnus, AF 49(638)-229, Aug 58, (38:3), Unclassified, AD 201 501.

The theory of diffraction of electromagnetic waves by a sphere requires a knowledge of the zeros of certain transcendental functions. This report is concerned with the problem of determining the zeros of the Hankel function of the first kind $H_\nu^1(x)$ for fixed real x and variable ν. In the simplest case of a perfectly conducting sphere of radius a, the equation in question is $H_\nu^1(ka) = 0$. While the explicit values of ν are not given for each value of the argument ka, the behavior of ν as a function of the argument is examined, and certain relations are derived between the real and imaginary parts of ν and the argument ka. In addition the more complicated transcendental functions which occur in the case of a sphere of finite conductivity are examined, and the behavior of ν as a function of its argument is determined. This work gives a thorough mathematical background for theoretical work in the diffraction of electromagnetic waves by conducting spheres.

5589 Research Report EM-105 (AFCRC-TN-57-377), "Diffraction of a Dipole Field by a Unidirectionally Conducting Screen," J. Radlow, AF 19(604)-1717, May 57, (26:8), Unclassified, AD 117 079.

An exact solution is obtained for diffraction of a dipole field by a unidirectionally conducting, semi-infinite plane screen. An analysis based on the Wiener-Hopf method is used to derive an exact field in the form of real integrals, with which the variation of the fields and currents along the edge of the screen can be analyzed. Results are summarized in the form of a theorem, and it is verified that all boundary conditions of the problem are met.

5590 Research Report EM-108 (AFCRC-TN-57-974), "Diffraction of a Plane Wave by a Unidirectionally Conducting Half-Plane," S. N. Karp, AF 19(604)-1717, Aug 57, (20:4), Unclassified, AD 133 799.

NEW YORK UNIVERSITY, COURANT INSTITUTE OF MATHEMATICAL SCIENCES (CONT.)

5590 (Cont.)

A solution in closed form is given for diffraction of a plane electromagnetic wave by a semi-infinite unidirectionally conducting screen. The boundary-value problem is formulated and the wave function is then obtained explicitly in terms of functions associated with diffraction by a perfectly conducting half-plane. Finally, a simple asymptotic far-field solution is derived.

5591 Research Report EM-109 (AFCRC-TN-57-975), "Diffraction by a Smooth Object," B. R. Levy and J. B. Keller, AF 19(604)-1717, Dec 57, (58:13), Unclassified, AD 146 784.

This treatment of the diffraction of waves by a smooth convex opaque object of any shape is divided into two parts. In Part I, the geometrical theory of diffraction is applied to the general problem. Both scalar and vector fields are considered, and the diffracting objects may be of any type, acoustically hard or soft, perfect conductors, dielectrics, etc. In Part II, diffraction by various special shapes is formulated as a boundary-value problem and solved by the separation-of-variables technique. Asymptotic solutions obtained by this method are compared with the geometrical solutions of Part I. In each case, the leading terms in the expansion of the solution coincide with the simple geometrical results, thus verifying the geometrical theory.

5592 Research Report EM-110 (AFCRC-TN-58-130), "The Inverse Scattering Problem in Geometrical Optics and the Design of Reflectors," J. B. Keller, AF 19(604)-1717, Jan 58, (10:3), Unclassified, AD 146 887.

A short treatment of the inverse scattering problem, i.e., the problem of finding the properties of the scattering object when the incident radiation and the intensity of the scattered field in each direction are known. The two-dimensional case of cylindrical scatterers is treated, first with an incident plane wave and then with an incident wave due to a line source; in each case explicit formulas are obtained. Also treated is three-dimensional scattering from a surface of revolution, with a plane wave incident along the axis or with a point source located on the axis. The general problem of an arbitrary smooth convex closed reflecting surface in three-dimensional space is briefly discussed. It is indicated that in this general case the problem leads to too large a family of solutions when the scattered radiation pattern is known for only one direction of incident radiation. But if the scattered fields are given for two different incident waves coming in opposite directions, then the inverse problem has a unique solution. In the general case, the calculation of this solution requires that an elliptic partial differential equation be solved. The method of geometrical optics is used throughout.

5593 Research Report EM-111, "Diffraction of a Skew Plane Electromagnetic Wave by an Absorbing Right-Angled Wedge," F. Karal and S. N. Karp, AF 19(604)-1717, Feb 58, (57:10), Unclassified, AD 146 888.

An exact solution is found for the diffraction field of a three-dimensional wedge illuminated by a plane wave incident in an arbitrary direction. The solution of the diffraction field for perfectly conducting surfaces follows from Maxwell's equations by separation of variables. However, when boundary conditions are imposed such that one surface is perfectly conducting and the other surface is partially absorbing, this method of solution may no longer be used directly. An exact solution is then obtained by transforming the original fields and original boundary conditions to two new fields and a new set of boundary conditions. The

NEW YORK UNIVERSITY, COURANT INSTITUTE OF MATHEMATICAL SCIENCES (CONT.)

5593 (Cont.)

new equations containing the transformed field are reduced by separation of variables to two separate problems. The solutions of the transformed fields are then used to find exact solutions for the original fields. Finally, from the exact solutions of the original fields, an asymptotic solution of the far field is obtained.

5594 Research Report EM-113 (AFCRC-TN-58-171), "Multiple Scattering by a Random Stack of Dielectric Slabs," I. Kay and R. A. Silverman, AF 19(604)-3495, Apr 58, (25:3), Unclassified, AD 152 468.

A treatment of one-dimensional reflection from an array of dielectric slabs whose dielectric constants are independent samples of a Bernoulli random variable, with special emphasis on the role of multiple scattering. The slabs are assumed to be of infinite extent with equal widths, and a wave is incident normally on the stack. Approximations are obtained for reflection and transmission coefficients with multiple scattering neglected, and error estimates are obtained on these quantities. The effect of the random nature of the scattering medium in diminishing the error involved in neglecting multiple scattering is investigated. An upper bound is found for the strength of scattering of any order, taking the random nature of the medium into account. It is found that when the number of slabs is large, the Neumann series for the mean square transmission and reflection coefficients converge much more rapidly than would be inferred from the smallness of the perturbation of the incident field by the scattering medium.

5595 Research Report EM-115 (AFCRC-TN-58-197), "A Geometrical Theory of Diffraction," J. B. Keller, AF 19(604)-1717, Jul 58, (26:41), Unclassified, AD 152 454.

The theory of geometrical optics is modified to include diffraction effects by introducing new rays, called diffraction rays. These new rays account for the appearance of light in shadows and also alter the illumination in lit regions. The different situations in which diffracted rays are produced are enumerated, and the types of diffracted rays which occur in each case are described. Another formulation, based upon an extension of Fermat's principle, is also given. Diffracted wave fronts and rays are determined from solutions of the eiconal equation, and a number of examples are described to illustrate the theory. For those cases in which shadows remain even after the introduction of diffracted rays, the concept of a ray was extended to include imaginary rays. An amplitude function was introduced for the rays in order to provide a quantitative description of the light distribution. The report concludes with a discussion of the relation of the new theory to previous work on diffraction.

Note: This report is reprinted from the American Mathematical Society's Calculus of Variations and Its Application, L. M. Graves, Editor, McGraw-Hill Book Company, 1958.

5596 Research Report EM-119 (AFCRC-TN-58-589), "How Dark is the Shadow of a Round-Ended Screen?," J. B. Keller, AF 19(604)-1717, Oct 58, (5:4), Unclassified, AF 207 520.

If a screen having a rounded tip is illuminated by a plane electromagnetic wave, there will always be some illumination in the shadow of the screen. The intensity of this illumination depends upon the wavelength of the incident radiation, and upon the size and shape of the tip. The amplitudes of the fields

NEW YORK UNIVERSITY, COURANT INSTITUTE OF MATHEMATICAL SCIENCES (CONT.)

5596 (Cont.)

in the shadow have been determined as a function of b/λ for two types of screen. One screen has width 2b and a rounded tip of radius b, while the other is an infinitely thin screen with cylindrical tip of radius b. For the infinitely thin screen, the amplitude decreases monotonically as b/λ increases when the field vanishes on the screen. But if the normal derivative vanishes, the amplitude first oscillates as b/λ increases, and then finally decreases. For the screen of width 2b (the more realistic one), the amplitude probably decreases monotonically in both cases as b/λ increases. The calculations are based on the geometrical theory of diffraction, and the results are in almost exact agreement with series solution for $kb > 4$.

5597 Research Report EM-120 (AFCRC-TN-59-130), "Relation Between a Class of Two-Dimensional and Three-Dimensional Diffraction Problems," L. B. Felsen and S. N. Karp, AF 19(604)-1717, Jan 59, (22:7), Unclassified, AD 210 493.

By means of a transformation, a relationship is demonstrated between classes of two-dimensional and three-dimensional scalar or electromagnetic diffraction problems. The basic three-dimensional configuration consists of a perfectly reflecting half plane excited by a ring source centered about the edge and having a variation $\exp(\pm i\phi/2)$, where ϕ is the azimuthal variable; in addition, a perfectly reflecting rotationally symmetrical obstacle whose surface is defined by $f(\rho,z) = 0$ (ρ,z are cylindrical coordinates), may be superposed about the edge (z-axis). This problem is shown to be simply related to the two-dimensional one for the line-source excited configuration $f(y,z) = 0$, where y and z are Cartesian coordinates. Various special obstacle configurations are treated in detail. For the general case of arbitrary electromagnetic excitation, the above-mentioned transformation is used to construct the solution for diffraction by a perfectly conducting half plane, making use of knowlege of scalar solutions which obey the same equations and boundary conditions, and which have the same excitations, as the Cartesian components of the electromagnetic field.

Note: This report was also issued by the Polytechnic Institute of Brooklyn (Microwave Research Institute) as Report R-694-58, PIB-622 under Contract AF 19(604)-4143.

5598 Research Report EM-121 (AFCRC-TN-59-103), "Diffraction by an Elliptic Cylinder," B. Levy, AF 19(604)-1717, Dec 58, (33:6), Unclassified, AD 208 235.

The boundary-value problem corresponding to a cylindrical wave incident upon an acoustically soft or acoustically hard elliptic cylinder is formulated and solved by the separation-of-variables technique. The short-wavelength expansion of the field is found by applying geometrical-optics theory, and this result is compared with asymptotic expansion of the exact solution. For both the soft and hard cylinders, it is shown that the geometrical solution is the leading term in the asymptotic expansion of the exact solution. The asymptotic expansion of both methods along with some identities necessary for their comparison are derived in the appendix.

5599 Research Report EM-122 (AFCRC-TN-58-592), "Multiple Scattering in One Dimension," J. Bazer, AF 19(604)-3495, Jan 59, (66:13), Unclassified, AD 207 910.

NEW YORK UNIVERSITY, COURANT INSTITUTE OF MATHEMATICAL SCIENCES (CONT.)

5599 (Cont.)

A rigorous treatment of two basic types of one-dimensional problems in the theory of multiple scattering of waves by distributions of point scatterers. The first problem concerns scattering by a single configuration of scatterers with fixed but arbitrary positions in a finite scattering interval. The second problem concerns scattering from an ensemble of configurations, the ensemble arising out of the assumption that the scatterer positions are random variables. In each problem the solution u^n (n denotes the number of scatterers) is approximated by the solution U^n of a continuum problem that results when the discrete distribution function $W^n(x)$, characterizing the spatial distribution of scatterer positions, is replaced by an approximating continuous distribution function $W(x)$. The results provide rigorous justifications, in a one-dimensional setting, for two formal procedures now in wide use.

5600 Research Report EM-123 (AFCRC-TN-59-100), "Diffraction of a Plane Wave by a Right Angled Wedge Which Sustains Surface Waves on One Face," F. C. Karal, Jr. and S. N. Karp, AF 19(604)-1717, Jan 59, (22:20), Unclassified, AD 208 046.

Study on diffraction of a plane electromagnetic wave incident on a right-angled wedge, one of whose sides is perfectly conducting and the other having a prescribed boundary condition. The impedance boundary condition is such that surface waves are generated. The problem is not separable in the usual manner because of the mixed boundary condition. This difficulty was overcome by introducing an auxiliary function which is a linear combination of the magnetic field and its Cartesian derivatives that satisfies the wave equation. Once this function is found, the original field is determined by solving an auxiliary partial differential equation. An exact mathematical solution is presented, from which the amplitude of the surface wave is found. A simple asymptotic representation for the far field is also given.

5601 Research Report EM-126 (AFCRC-TN-59-138), "Higher Order Approximations in Multiple Scattering: I. Two-Dimensional Scalar Case. II. Three-Dimensional Scalar Case," N. Zitron and S. N. Karp, AF 19(604)-1717, Mar 59, (40:14), Unclassified, AD 211 521.

Scattering of a plane electromagnetic or acoustic wave by two arbitrary cylinders is considered. The perturbed scattering amplitudes of the two cylinders are given as a function of the unperturbed scattering amplitudes of the individual cylinders. The formula involves derivatives of the scattering amplitudes with respect to the angles of incidence and of observation, and is valid when the spacing d of the scatterers is large compared to their dimensions and to λ. Interaction terms of degree $d^{-1/2}$, d^{-1}, and $d^{-3/2}$ are taken into account, and a physical explanation is provided of the terms appearing in the relation for the scattered field. The total scattering cross-section is determined from the expression for the scattered field. The method is then extended to cover the three-dimensional scalar problem for two bodies of arbitrary shape; interaction terms of order d^{-1} and d^{-2} are determined along with an expression for the perturbed far-field amplitude.

NEW YORK UNIVERSITY, COURANT INSTITUTE OF MATHEMATICAL SCIENCES (CONT.)

5602 Research Report EM-127 (AFCRC-TN-59-144), "Back Scattering from a Finite Cone," J. B. Keller, AF 19(604)-1717, Feb 59, (18:15), Unclassified, AD 211 808.

Backscatter cross-section is calculated for both acoustic and electromagnetic plane waves incident on cones of two different shapes. The backscattered wave is obtained by the method of geometrical optics for a cone with a flat base, and for one with a spherical base. The results are presented in two graphs which give backscatter cross-section vs. cone angle and vs. wavelength for axial incidence on the flat-based cone. Suggestions are given for the shaping of a cone to minimize backscatter cross-section.

5603 Research Report EM-129 (AFCRC-TN-59-166), "Two Dimensional Green's Function for a Right Angled Wedge Under an Impedance Boundary Condition," S. N. Karp, AF 19(604)-1717, Mar 59, (19:12), Unclassified, AD 213 608.

A solution of the two-dimensional Green's function for a right-angled wedge when a constant impedance boundary condition is imposed on one face, while on the other face, either the function or its normal derivative is required to vanish. In physical terms, the solution of the diffraction field of a right-angled wedge, illuminated by a plane electromagnetic or acoustic wave at incidence angle θ_o, wit the requirement that one face be perfectly reflecting, while the other face assume a prescribed impedance. The faces of the wedge lie along the +x and -y axes and the incidence angle θ_o measured from the +x axis has the domain $0 \leq \theta_o \leq 3\pi/2$. Mathematically, the requirement at the $\theta = 0$ boundary is that the solution U or $\partial U/\partial\theta$ vanish, and at the $\theta = 3\pi/2$ boundary $\lambda_1 \partial U/\partial\theta = \lambda_2 rU$, where λ_1 and λ_2 are certain complex numbers, and r and θ are polar coordinates. For $\lambda_1 \neq 0$, $\lambda_2 \neq 0$, the Green's function is expressed in elementary fashion, by quadratures and differentiations, in terms of the Green's function of the problem with $\lambda_1 = 0$ or $\lambda_2 = 0$.

5604 Research Report EM-130 (AFCRC-TN-59-189), "Diffraction by a Spheroid," B. R. Levy and J. B. Keller, AF 19(604)-1717, Mar 59, (30:8), Unclassified, AD 215 375.

The diffraction field which results when a cylindrical scalar wave is incident on a spheroid is determined. The field equations are determined by two different methods for ka >> 1. The first result is based on the geometrical theory of diffraction. In the other approach, the boundary-value problem is solved exactly, and the asymptotic form of the field is determined. This result is in agreement with the geometrical theory. The scattered field and the backscatter cross-section for an electromagnetic wave incident on a perfectly conduct ing spheroid is computed with the aid of a theorem which relates it to the two scalar results. Errors in previous treatments of the problem are pointed out in an appendix.

5605 Final Report (AFCRC-TN-59-144), "Basic Mathematical Investigations in Electromagnetic Wave Theory," AF 19(604)-1717, Mar 59, (23:27), Unclassifie AD 215 113.

This short report merely summarizes the work done on the contract with references to reports and published papers in which the details were reported. A complete bibliography of documents issued under the contract is included.

NEW YORK UNIVERSITY, COURANT INSTITUTE OF MATHEMATICAL SCIENCES (CONT.)

5606 Research Report EM-131 (AFCRC-TN-59-177), "Boundary Layer Problems in Diffraction Theory," R. N. Buchal and J. B. Keller, AF 19(604)-5238, Apr 59, (44:7), Unclassified, AD 214 569.

This report treats singularities encountered on caustics and across shadow boundaries on surfaces when the theory of geometrical optics is applied to diffraction problems. The wave motion determined by geometrical optics is the high-frequency asymptotic form of the solution of the boundary-value problem. The author contends that the singularities of the geometrical-optics wave motion are asymptotic phenomena associated with boundary layers. The field may be expanded in these layers, thus provided expansions which are finite at the caustics and continuous at the shadow boundaries.

A specific example treated concerns diffraction of a plane wave by a thin screen containing an aperture. Boundary layers occur around the edge of the aperture and in other places. A number of terms in the asymptotic expansion of the field are determined, and a method is devised which can be used to find additional terms. Results verify and extend previous analyses of this problem.

5607 Research Report EM-138 (AFCRC-TN-59-567), "Fields in the Neighborhood of a Caustic," I. Kay, AF 19(604)-3495, Sep 59, (20:4), Unclassified.

An investigation of the asymptotic behavior of a field on or near a caustic. Starting with Picht's solution of the wave equation in the form of an integral of plane waves over a caustic, expressions for the solution are derived which depend entirely on the geometry of the problem.

5608 Research Report EM-140 (AFCRC-TN-59-584), "Reflection and Transmission by a Class of Curved Dielectric Layers," S. N. Karp, AF 19(604)-5238, Aug 59, (16:2), Unclassified, AD 228 550.

This report is concerned with the two-dimensional reflection and transmission properties of a special class of curved slabs of dielectric material which may have either a real or complex dielectric constant. The curved layer considered is confined between two confocal parabolas, and has a refractive index which tends toward that of free space with increasing distance from the nose of the layer. For a plane wave incident normally on the convex side of the curved layer, the transmitted and reflected waves are determined analytically and found to be similar to those obtained from a plane dielectric surface. Comparison with results for the plane dielectric surface shows that the transmitted wave in both cases is a plane wave which is given by the incident field multiplied by a transmission coefficient that depends on the frequency, and on the slab configuration and material. In both cases, the reflected field is the product of a space-independent but slab-dependent reflection coefficient and the field which would be reflected if the back surface of the slab were silvered, and then the slab removed. For both cases the fields have simple space dependence, and a rather complicated dependence on frequency, slab material and thickness except for special elementary cases.

5609 Research Report EM-143 (AFCRC-TN-59-995), "Multiple Diffraction by an Aperture in a Hard Screen," S. N. Karp and J. B. Keller, AF 19(604)-5238, Nov 59, (18:8), Unclassified.

Diffraction of a plane wave incident normally on an aperture in a hard screen (one on which the normal component of the field vanishes) is treated, using two methods previously applied to diffraction by an aperture in a soft screen

NEW YORK UNIVERSITY, COURANT INSTITUTE OF MATHEMATICAL SCIENCES (CONT.)

5609 (Cont.)

(one on which the field vanishes). The geometrical theory of diffraction is employed to determine the diffracted field produced by slits, circular apertures, and other shaped apertures in a hard screen, while the self-consistent-field method is applied to diffraction by an infinite slit. Both near and far fields can be calculated by the latter method, provided slit width is large. Expressions are found for the diffracted fields, the diffraction patterns, and the transmission cross-section in each case. It is shown that fields calculated by each method yield the same result at distances greater than a few wavelengths from the edge of the screen.

5610 Research Report EM-144 (AFCRC-TN-59-594), "Diffraction of Scalar Waves by a Circular Aperture," J. Bazer and A. Brown, AF 19(604)-5238, Aug 59, (38:12), Unclassified.

Study of diffraction by a circular aperture in a perfectly soft or perfectly rigid, infinite, planar screen. Although the method derived to solve these problems is applicable to any arbitrary axially symmetric excitation, only normal incidence by a plane wave is here considered. New integral representations of the solutions to the respective problems are considered and shown to be simple, and to lead directly to Fredholm integral equations of the second kind. They are used to calculate approximate expressions for aperture fields, far fields, transmission coefficients, and edge behaviors. The merit of this approach lies in the simplicity of the integral representations and the greater accuracy (compared with other methods) achieved by including higher powers of ka.

5611 Research Report EM-145 (AFCRC-TN-59-596), "A New Method for the Determination of Far Fields with Applications to the Problem of Radiation of a Line Source at the Tip of an Absorbing Wedge," F. C. Karal, Jr. and S. N. Karp, AF 19(604)-5238, Sep 59, (26:9), Unclassified.

A simple method is devised for determining the diffracted far field for wedges with mixed impedance boundary conditions. Excitation by either an incident plane wave or a line source located at the tip of the wedge is considered, although the latter is emphasized. This particular problem cannot be solved by separation of variables because of the mixed boundary conditions. An operator is introduced which transforms the original impedance boundary conditions into simple boundary conditions involving an auxiliary function whose solution is known. This operator technique yields a particularly simple method for solving far-field equations and constitutes the most important result of the paper. The new method is applied to determine the radiated far field of a line source located at the tip of a wedge. It is also shown how the method described in the paper can be employed in the direct derivation of the diffraction pattern for perfectly conducting wedges.

5612 Research Report EM-155 (ERD-TN-60-756), "On an Integral Equation Arising in Inverse Scattering," C. H. Yang, AF 19(604)-3495, Apr 60, (29:0), Unclassified, AD 244 089.

A method of Fourier transforms and double series is applied to solve the following integral equation arising in inverse scattering:

$$\int_{-t}^{x} R(t+y)\ K(x,y)\ dy + K(x,t) + R(x+t) = 0\ , \qquad t \leq x$$

NEW YORK UNIVERSITY, COURANT INSTITUTE OF MATHEMATICAL SCIENCES (CONT.)

5612 (Cont.)

where R(w) is a Fourier transform of the given reflection coefficient in the differential equation

$$U''(k,x) + [k^2 - V(x)]U(k,x) = 0 . \qquad -\infty < x < \infty$$

By assuming R(w) to be analytic, the unknown function can be constructed in the following forms:

$$(1) \quad K(x,y) = \sum_{n=0}^{\infty} A_n(x)y^n; \qquad (2) \quad K(x,y) = \sum_{p=0}^{\infty} \sum_{m+n=p} C_{m,n} x^m y^n .$$

The series converge uniformly and absolutely for $|x| < x(R)$; $x(R)$ depends on R(w). Therefore, if the reflection coefficient of the above differential equation is given with suitable conditions, V(x) can be found by solving the integral equation and by the relation $V(x) = 2 \frac{d}{dx} K(x,x)$.

5613 Research Report EM-156 (AFCRC-TN-60-195), "Diffraction by an Elliptic Cone," L. Kraus and L. M. Levine, AF 19(604)-5238, Mar 60, (25:11), Unclassified.

Solution of the boundary-value problems corresponding to a spherical wave incident on an acoustically soft or hard elliptic cone, or a plane angular sector. These problems are solved by separation of variables in the sphero-conal coordinate system. The special functions which arise are shown to be simple periodic and non-periodic solutions of the Lamé differential equation.

5614 Research Report EM-162 (AFCRL-TN-60-973), "The Shift of the Shadow Boundary and the Scattering Cross Section of an Opaque Object," S. I. Rubinow and J. B. Keller, AF 19(604)-5238 and Nonr-263(30), Sep 60, (20:6), Unclassified, AD 245 623.

When a wave is incident upon an opaque object of typical dimension a, which is large compared to the incident wavelength, a shadow is formed. In the geometrical-optics limit, $\lambda/a = 0$, the shadow is bounded by optical rays tangent to the object. However, when λ/a is small but not zero, the shadow boundary is parallel to, but displaced slightly from, the geometrical shadow boundary. This shift has been derived by other authors, and is shown in this report to be asymptotically equal to $\alpha(\lambda^2 a)^{1/3}$, where α is a positive or negative proportionality constant. The important result is that since fields propagate along rays when λ/a is small, it is shown that the shadow boundary shift is a local effect. The term α is shown to depend only on the radius of curvature of the shadow-forming cylinder at the point of tangency of the geometrical shadow boundary. Hence the shift for a circular cylinder of radius a is equal to the shift for a parabolic cylinder which has a radius of curvature a at the point of tangency. The total scattering cross-section per unit length of a circular cylinder on which the field satisfies an impedance boundary condition is calculated, and it is shown that the deviation from the geometrical-optics cross-section is proportional to the shift of the shadow boundary.

NEW YORK UNIVERSITY, COURANT INSTITUTE OF MATHEMATICAL SCIENCES (CONT.)

5615 Research Report EM-163, "Scattering from a Penetrable Sphere at High Frequencies," S. I. Rubinow, Nonr-258(48), Dec 60, (-:23), Unclassified, AD 256 020.

(BD-4212) A scalar plane wave incident on a penetrable sphere is considered in the short-wavelength limit. Introduced is a new representation of the scattering amplitude particularly appropriate in this limit, and which requires only evaluation of certain integrals. Some of these may be evaluated asymptotically by the method of steepest descent and lead to the geometrical-optics field contribution. Included is the bow field. The remainder of the integrals are evaluated by the method of residues and lead to the diffracted field contribution. This "diffracted ray" field is known from recent investigations in diffraction theory. An essential part of the analysis is the introduction of a parameter p, the number of internal refractions undergone by a ray which hits the sphere. Results obtained are in agreement with those expected on the basis of geometrical diffraction theory.

5616 Research Report EM-165 (AFCRL-TN-60-1170), "The Inverse Problem in the Quantum Theory of Scattering," L. D. Faddeyev, AF 19(604)-3495, Dec 60, (106:66), Unclassified, AD 254 856.

A survey of the inverse problem arising in the quantum theory of scattering. Basically, the paper is concerned with one fundamental problem. Given a wave function $\psi(x,k)$, which describes the steady-state of a system, find the relationship between the energy operator L, defined by

$$L\psi = -\frac{d^2\psi}{dx^2} + q(x)\psi = k^2\psi \ ,$$

and the scattering or S-matrix given by $S(k) = \exp[-2i\eta(k)]$, where $\eta(k)$ is defined by

$$\psi\Big|_{R\to\infty} \approx \frac{C(k)}{2i}\left[\exp[ikx - i\eta(k)] - \exp[-ikx + i\eta(k)]\right] ,$$

and k = wave number characterizing the energy of the state ψ. The asymptotic behavior of ψ can be written simply as $\psi\Big|_{R\to\infty} = \psi_1 + \psi_2$, where ψ_1 and ψ_2 represent incoming and outgoing waves, respectively. The S-matrix relates the amplitudes of these two waves. The mathematical theory investigated in this report can be applied to scattering phenomena in electromagnetism as well as in quantum mechanics.

Note: This is a translation of: Uspekhi Matem. Nauk. 14, No. 4 (88), 57 (1959).

5617 Research Report EM-170 (AFCRL-312), "Diffraction of Scalar Waves by a Circular Aperture-II," J. Bazer and H. Hochstadt, AF 19(604)-5238, Apr 61, (56:14), Unclassified.

This report concerns the problem of diffraction by a circular aperture in a perfectly soft or perfectly rigid infinite planar screen. The low-frequency end of the spectrum is considered for non-axially symmetric excitation consisting of a superposition of modes. Previously known solutions for axially-symmetric

NEW YORK UNIVERSITY, COURANT INSTITUTE OF MATHEMATICAL SCIENCES (CONT.)

5617 (Cont.)

excitation are generalized, and the solutions to the non-axially symmetric excitation takes the form of integral representations which are related to certain unknown functions. These representations are designed to satisfy automatically the time-reduced wave equation, the boundary conditions, and the Sommerfeld radiation condition, and to have the proper edge behavior. Application of results is made to the special case of plane-wave excitation. Approximate expressions, in powers of ka, are derived for the far fields, transmission coefficients, aperture fields, and edge fields of the solutions associated with the first three modes in the Fourier-Bessel expansion of the plane wave; the leading term as well as several higher order terms are given for each quantity.

5618 Research Report EM-174 (AFCRL-62-504), "The Three-dimensional Inverse Scattering Problem," I. Kay, AF 19(604)-3495, Jun 62 [also stated as Jul 62], (39:3), Unclassified.

The determination of the electron-density variation in an ionized gas such as the earth's atmosphere by means of radio sounding experiments is studied with the aid of inverse scattering theory borrowed from quantum mechanics. The problem is one of determining the variation of electron density in a weakly ionized gas from the knowledge of the scattering amplitude resulting from the incidence of a plane electromagnetic wave. A plasma somewhat more general than the specific problem in question is formulated and a differential equation similar to the time-independent Schrödinger equation is solved in three dimensions. For this general case, conditions sufficient to guarantee the uniqueness of the solution are imposed.

5619 Research Report EM-182 (AFCRL-62-943), "Scattering of Short Waves," J. B. Keller and B. R. Levy, AF 19(604)-3495, Oct 63, (24:15), Unclassified, AD 423 345.

A modified geometrical optics method is presented to solve the problem of high frequency scattering from an inhomogeneous region. Among the problems considered are those of determining the forward scattering amplitude and of analyzing the field in the neighborhood of a caustic.

Note: This is a reprint of a symposium paper (Abstract 8604J).

5620 Research Report EM-188 (AFCRL-63-348), "Diffraction at High Frequencies by a Circular Disc," D. S. Jones, AF 19(604)-5238, Jul 63, (93:30), Unclassified, AD 424 124.

The integral equation for the pressure distribution on a circular disk in an axisymmetric sound wave is converted into a singular integral equation of the first kind. This singular integral equation is mathematically suited to transformation into an integral equation of the second kind which is especially useful at high frequencies. An iterative procedure is used in the solution of integral equation of the second kind. From this solution, the resulting distribution on the disk and the high-frequency scattering coefficient is found for an incident plane wave. The resulting disk distribution and scattering coefficient are found for both the soft and hard disks. (See also next abstract.)

5621 Research Report EM-189 (AFCRL-63-369), "Diffraction of a High-Frequency Plane Electromagnetic Wave by a Perfectly Conducting Circular Disc," D. S. Jones, AF 19(604)-5238, Jul 63, (62:24), Unclassified, AD 436 111.

NEW YORK UNIVERSITY, COURANT INSTITUTE OF MATHEMATICAL SCIENCES (CONT.)

5621 (Cont.)

A method developed for the scalar case (preceding abstract) is generalized so as to apply to the diffraction of a normally incident, plane electromagnetic wave. This method leads to a straightforward representation of the asymptotic behavior of the field at high frequencies. The scalar equations are converted into a singular integral equation of the first kind which is especially suited for handling at high frequencies. A general formula for the scattering coefficient is derived, and evaluated at high frequencies.

5622 Research Report EM-195, "Diffraction of Electromagnetic Waves by a Circular Aperture in an Infinitely Conducting Plane Screen," J. Bazer and L. Rubenfeld, AF 19(604)-5238, Mar 64, (44:17), Unclassified, AD 600 132.

The subject problem is reviewed, using a simplified representation of the scalar waves corresponding to the usual E- and H-mode excitation with the requirement that the product ka is small. The derived scaler fields have several noteworthy features. They are relatively elementary in form, and for small ka yield explicit formulas for the field everywhere in space and over the aperture. The scalar field equations are designed to satisfy automatically Maxwell's equations, and require no knowledge of special-function theory in deriving other field equations from them. Using these equations, the first few terms of the power series for the electric field in the aperture, the edge fields, the far-field amplitudes, and the transmission coefficients are derived.

5623 Research Report EM-196 (AFCRL-64-399), "The Progressing Wave Formalism," R. M. Lewis, AF 19(628)-3868, May 64, (32:13), Unclassified, AD 457 975.

The progressing wave formalism is discussed in detail as a means for achieving approximate solutions to difficult boundary-value problems. The formalism is applied to time-independent progressing waves, radiation by moving sources, and reflection by moving surfaces.

Note: This report is a reprint of a symposium paper (Abstract 8646J).

5624 Research Report EM-199 (AFCRL-64-426), "A Plane Wave Expansion Theorem for Cylindrically Radiated Fields," S. N. Karp and N. R. Zitron, AF 19(628)-3868, May 64, (13:8), Unclassified, AD 602 236.

This report is concerned with the relation between a cylindrically radiated wave and a plane wave. The relation is shown to be expressible as an asymptotic series in terms of inverse powers of the distance from the point of radiation. The coefficients of these expansion terms are shown to be linear combinations of plane waves and their derivatives with respect to angle of incidence. Any general cylindrical wave may be expressed by means of this expansion as a plane wave in the coordinate system of the scattering object, with a correction term for wavefront curvature in the neighborhood of the scatterer which appears in the form of derivatives of the plane wave with respect to the incidence angle. This expansion may be used to determine the scattering field from a cylindrical scatterer caused by incident radiation from any general cylindrical wave, and also to reduce multiple-scattering problems to single-scattering problems. Both cases may be treated in a general manner without detailed knowledge of the incident wave or scattering object.

NEW YORK UNIVERSITY, COURANT INSTITUTE OF MATHEMATICAL SCIENCES (CONT.)

5625 Research Report MME-5, "On the Measurement of Virtual Height," I. Kay, DA 49-170 SC-2253, Jul 57, (11:3), Unclassified, AD 145 651.

A new definition advanced for the virtual height $h'(\omega_o)$ of the ionosphere is applicable to some reflected waves for which the virtual height cannot be determined by inspection in the usual manner. The new definition is time-dependent, and its accuracy increases as the width of the incident pulse increases. It is given by

$$h'(\omega_o) = \lim_{w\to\infty} c\left[\int_{-\infty}^{\infty} t|R(\omega_o,w,t)|^2\,dt \Big/ \int_{-\infty}^{\infty} |R(\omega_o,w,t)|^2\,dt - \int_{-\infty}^{\infty} t|I(\omega_o,w,t)|^2\,dt \Big/ \int_{-\infty}^{\infty} |I(\omega_o,w,t)|^2\,dt\right].$$

Here $I(\omega_o,w,t)$ is the incident pulsed signal, $R(\omega_o,w,t)$ is the reflected signal, and c is the velocity of light. The parameter w is a positive constant, not very clearly defined by the author, but which is said to roughly fix the width of the pulse in the sense that as w becomes large, $I(t/w)$ remains near its value at $t = 0$ for a large range of t; for a square pulse, w is pulse width.

5626 Research Report MME-7, "Diffraction in Inhomogeneous Media," B. D. Seckler and J. B. Keller, DA 49-170 SC-2253, Nov 57, (68:16), Unclassified.

The geometrical theory of diffraction is used to find the field diffracted by smooth convex bodies in an inhomogeneous medium. It is shown that this method is capable of describing the diffracted field in the shadows, and also yields diffraction corrections to the geometrical-optics field in illuminated regions. In Part I the theory is applied to several problems in which the medium is plane or cylindrically stratified and the boundary planar or circular. In Part II the equivalent problems are considered from the viewpoint of boundary-value problems for partial differential equations. Only those cases which can be solved exactly by the method of separation of variables are considered. It is shown that for large ka the geometrical solutions coincide with asymptotic expansions of the exact solutions to the boundary-value problems.

5627 Research Report MME-9, "Scattering of Plane Waves by Locally Homogeneous Dielectric Noise," R. A. Silverman, DA 49-170 SC-2253, Dec 57, (13:6), Unclassified, AD 154 876.

A theoretical treatment of the scattering of acoustic and electromagnetic radiation by random fluctuations of the refractive index of the medium (here called "dielectric noise"). The conventional mathematical attack on this problem assumes that the dielectric noise is a "section" of a homogeneous (i.e., spatially stationary) random process. This report describes an alternative mode of attack, in which the dielectric noise is represented as a locally homogeneous random process (i.e., one stationary in some local sense only). The new approach is based on earlier work of the author ("Locally Stationary Random Processes," IRE Trans. on Information Theory IT-3, 182-87 (1957)). It is found that when plane waves are scattered by locally homogeneous dielectric noise, the local structure of the noise determines the average scattered power received at a fixed point, whereas the overall structure of the noise determines the space correlations

NEW YORK UNIVERSITY, COURANT INSTITUTE OF MATHEMATICAL SCIENCES (CONT.)

5627 (Cont.)

of the radiation received at two different points. The entire treatment is restricted to observations made in the Fraunhofer condition.

5628 "Reflection from Inhomogeneous Plane Stratified Media," Parts I and II, I. Kay, AF 33(616)-5067, Unclassified.

Part	Report	Date	Pages:Refs.	AD No.
I	WP-1	Jan 58	19:4	153 533
II	WP-2	Mar 58	18:1	162 614

An approximation technique due to H. Bremmer (Symposium on the Theory of Electromagnetic Waves, pp. 169-180, Interscience, New York, 1951) and others is used to treat the reflection of electromagnetic radiation from a plane stratified inhomogeneous dielectric medium. This approximation involves a series solution, of which the WKB approximation is the first term. Plane waves of arbitrary polarization are assumed incident at arbitrary angle within an adjacent homogeneous medium. The dielectric parameter, permeability, and conductivity of the stratified medium vary (perhaps discontinuously) in the direction normal to the plane surface of the medium, but not parallel to it. Approximate expressions are obtained for the upward- and downward-moving components of the wave in the stratified medium, under the condition that the "total variation" in the characteristic impedance of the medium is small. A useful feature of this treatment is that an error estimate on the approximation is found, and a frequency-independent bound on the error estimate is then established.

The second report extends the above work, and comprises two essentially independent topics. In the first section, it is demonstrated that the approximation is still valid when the characteristic impedance is allowed to have jump discontinuities. In the second portion of this report, a more general perturbation approach is described, which is applicable to some cases where the small-variation approximation is unsuited. The solution for the actual medium is found as a perturbation on the solution for some standard medium whose properties are not too different.

5629 Research Report WP-4, "A Program for Computing Reflection Coefficients," I. Kay and S. Lieberman, AF 33(616)-5521, Oct 59, (11:-), Unclassified, AD 231 508.

Description of a computer program for Univac, with which there can be calculated the reflection coefficient of a stack of plane dielectric slabs of arbitrary dielectric constants, permeabilities, and conductivities. Plane electromagnetic radiation is assumed incident on the slabs from a medium of arbitrary properties at any angle and with any angle of polarization.

NORTH AMERICAN AVIATION, INC. (COLUMBUS)

5630 Final Report NA60H-561, "Specular Echo Area Measurement of F9F-6 Airplane," N123(61756)23286A(PMR), 15 Sep 60, (165:4), Unclassified, AD 285 495.

The radar echo area of the F9F-6 airplane was measured at monostatic and selected bistatic angles, using optical simulation techniques. A 1/25-scale model was constructed of plexiglass and coated with aluminum. Measurements were performed in a dark room, where the model was illuminated by a white-light source chopped at 560 cps. The receiver of the reflected white light was a photomultiplier tube

NORTH AMERICAN AVIATION, INC. (COLUMBUS) (CONT.)

5630 (Cont.)

which fed a narrow-band (4 cps) amplifier filter whose output was detected and fed to a strip-chart recorder. Measurement procedures, instrumentation, and calibration are briefly described. The reduced data were prepared in polar form; approximately 140 pages of polar plots are included.

NORTH AMERICAN AVIATION, INC. (LOS ANGELES)

5631 Report TFD-61-265-SST, "Lossy Dielectric Radar Absorber Fabrication," J. Yurk, 7 Mar 61, (3:1), Unclassified, AD 283 203L. (Only government agencies may request from DDC. Others request approval of Aeronautical Systems Division, Wright-Patterson AFB, Ohio. Attn: ASRSMS.)

The mixing procedure for preparing acetylene-black-loaded silicone laminates is briefly described. Greater than 15% acetylene-black causes a prohibitive rise in dielectric constant.

5632 Report TFD-61-976, "Fabrication of Large Lossy Test Panel," J. Berry, 25 Oct 61, (3:1), Unclassified, AD 283 216L. (Only government agencies may request from DDC. Others request approval of Aeronautical Systems Division, Wright-Patterson AFB, Ohio. Attn: ASRSMS.)

This brief sketch reports that a 3/4 x 24 x 24-inch lossy dielectric laminate was fabricated using DC 2106 silicone prepreg containing approximately 5% acetylene-black in the resin on 2P-127 Volan A glass fabric.

5633 Report SID-63-686, "Radar Absorptive Materials. A Survey," 3 Jun 63, (23:96), Unclassified, AD 421 454.

Bibliographic information for 89 references concerning the use of radar absorptive materials to reduce cross-section. A sentence serves to describe unclassified reports; classified entries include descriptors only. Most references show publication dates in the 1960's. Entries are arranged alphabetically by author; a brief subject index follows.

NORTHROP CORPORATION, RADIOPLANE DIVISION

5634 Report 2264, "KDB-1 Reflectivity Measurements," N123(61756)22718A, 1 Jun 60, Unclassified.

Note: This report was not obtained.

NORTHROP CORPORATION, VENTURA DIVISION

5635 RADC-TRD-2489, "Spherical Scattering Centers Utilized as Passive Satellites," K. H. Kriz, AF 30(602)-2460, 10 Jan 62, (97:8), Unclassified, AD 274 941.

Investigation of the properties of spherical scattering elements and their application in regular linear, two-dimensional, and three-dimensional arrays and in reflectors with a random distribution of spherical elements, including a short study of resonant ring elements. Theoretical results were supplemented by experimental measurements made with a system designed and constructed for very small radar cross-sections (down to 10^{-4} m^2). Results of the study were applied to the preliminary design of a passive communications satellite using regular arrays of spherical elements.

NORTHROP CORPORATION, VENTURA DIVISION (CONT.)

5636 Report T.P.-68, "Scattering by Perfectly Conducting Arbitrarily Shaped Cylinders," R. P. Banaugh, 26 Aug 63, (15:9), Unclassified, AD 417 235.

The problem of determining the scattered field from a perfectly conducting cylinder of arbitrary cross-sectional shape is formulated in terms of an integral equation and solved by a finite-difference technique. Results are presented for a cross-section which is not a convex domain, and the efficacy of the numerical solution is compared with results computed from eigenfunction expansions. The basis of comparison was different from the usual one which employs results obtained from static-potential problems.

5637 Report NVR-3503, "The Effect of Small Irregularities on Electromagnetic Scattering from an Interface of Arbitrary Shape," K. M. Mitzner, May 64, (37:13), Unclassified, AD 600 543.

An approximate method for determining the effect of slight irregularities on the scattering from an interface of arbitrary underlying shape. The analysis was carried out to second order in the maximum irregularity amplitude ϵ, where ϵ is a small displacement parameter characterizing the irregularity. The approach is valid when the irregularity has small slope and an amplitude small compared to the wavelengths and local radii of curvature. The theory of dyadic Green's functions was developed to facilitate applications; the necessary functions are given for some important geometries.

Note: This report is based on the author's Ph.D. thesis, submitted to the California Institute of Technology.

NORTHWESTERN UNIVERSITY

5638 AFOSR-64-2543, "Backscattering From Cellular Materials," M. A. Plonus, AF 49(638)-1377, Sep 64, (2:2), Unclassified, AD 453 886.

Brief comments on the contribution of cellular or foamed-plastic supports to the measured cross-section of low-cross-section test specimens.

Note: This is a reprint of a paper in "International Conference on Microwaves, Circuit Theory and Information Theory--Part 1, Microwaves," Inst. Elect. Comm. Eng. Japan, Tokyo, 7-11 September 1964, pp 319-20.

OCEANICS, INC.

5639 Report 64-17, "The Application of Airborne Radar Backscatter to Measurement of the State of the Sea," W. Marks, Aug 64, (17:7), Unclassified, AD 604 414.

Explores the possibility of using radar backscatter from the sea surface as a measure of the waves present. Wave profiles were read from stereo photographs of the waves and reduced to statistics for comparison were also taken. The method of reduction used is based on the method by Schooley (Proc. IRE 52, No. 4, 456-61 (1962)). Calculations presented are claimed to be the first of their type ever made from actual sea-wave data and were considered exploratory. It was concluded that preliminary experiments indicated good correlation between wave and radar statistics, but the best statistic for use was not determined.

Ed: Although 11 figures including statistical results are presented, no detailed format is given for data reduction. Only a limited number of experiments were analyzed.

OFFICE OF RESEARCH ANALYSES (HOLLOMAN AIR FORCE BASE)

5640 Technical Report ORA-63-5, "The Combined Effect of Refraction, Doppler Shift, Aberration, and Light Drag on Signals Reflected from Missiles," B. Manz, Mar 63, (31:0), Unclassified, AD 299 081.

Elementary theory of Doppler shift, aberration, and "light drag" is developed for heterogeneous refractive media. The basic principle is the invariance of the phase function under the Lorentz transformation; from this, various formulas are derived for electromagnetic signals travelling from a source via a reflector to a receiver, each of which has a different velocity with respect to the medium.

Ed: Most, if not all, of the results can be found in many standard texts on advanced physics.

OHIO STATE UNIVERSITY RESEARCH FOUNDATION, ANTENNA LABORATORY

5641 Report 601-14, "The Echoing Area of Antennas," E. M. Kennaugh, AF 33(616)-2546, 20 Dec 57, (11:2), Unclassified, AD 152 786.

Factors which affect echo areas of parasitic antennas are discussed. A formula for the change in echo signal produced by load variations is derived and several applications of parasitic antennas for the purpose of echo modulation are suggested. In an appendix, it is shown that the maximum change in received current occurs when the load impedance of the parasitic-antenna target varies from open circuit to short circuit. In this case the variation in received current is the same as that produced by a scatterer having echo area $\sigma = (G^2\lambda^2)/\pi$, where G is the power gain of the parasitic antenna over an isotropic radiator in the given direction. Other applications of modulated parasitic antennas mentioned are: to produce echo scintillation for ECM purposes, to enable target identification, and to make secure communication links.

Note: Reports 1 through 13 of this series were abstracted in previous volumes, see Abstracts 2481 through 2490 and 4169 through 4171. The series bears the general title: "Techniques for Measurement of Radar Reflection Characteristics of Aircraft and Missiles." Many of the reports are classified and abstracts are in other volumes of this bibliography.

5642 Report 601-15, "Equipment for High-Speed Recording of Echo Area Patterns," P. D. Kennedy, AF 33(616)-2546, 1 Feb 57, (18:4), Unclassified, AD 128 910.

Backscatter reflectivity patterns for radar target models are commonly measured by feeding the signal to the receiver through a variable attenuator; a servo loop adjusts the attenuator to maintain constant input to the receiver. The amount of attenuation required to give constant output is therefore a measure of relative signal strength, and this quantity is fed to an indicator. This technique has the disadvantage of slow speed caused by the inertia of the servo motor, attenuator, and other mechanisms. Thus it is sometimes necessary to take up to an hour for one rotation of the target. The report describes an improved system that is capable of measuring patterns very rapidly. Received signals from the receiver preamplifier are fed to a logarithmic amplifier whose output is a voltage proportional to the decibel value of the input. This output can be recorded with a high-speed recorder. The action is so fast that, if desired, photographic techniques could be used to measure pulse-to-pulse variation in the signal.

OHIO STATE UNIVERSITY RESEARCH FOUNDATION, ANTENNA LABORATORY (CONT.)

5643 Report 601-16, "The 'Three-Axis' Target Control System," P. D. Kennedy, AF 33(616)-2546, 15 Apr 57, (10:1), Unclassified, AD 129 706.

Some limitations on the conventional method of making static model measurements of aircraft echo area are discussed and an improvement is proposed. The suggested improvement comprises a three-axis technique of model suspension that will allow the model to be given a complex motion in three dimensions so as to simulate the motion of an actual aircraft. The model is supported by four cords to upper and lower cross-shaped structures. Azimuth motion is obtained by rotating the entire system, while roll and pitch motions are produced by servo motors that pull the cords. A computer might be used to drive the system in order to provide dynamic simulation.

5644 Report 601-18, "Memorandum on Advanced Techniques for Radar Reflectivity Data Analysis," P. D. Kennedy, AF 33(616)-2546, 1 Apr 57, (21:3), Unclassified, AD 133 465.

Discussion on mechanized analysis of radar-reflectivity data obtained by static model measurements. Following general discussions of the objectives of data analysis and of operating features that seem desirable in analysis procedures, development of apparatus to perform the indicated tasks is described.

5645 Report 601-19, "On the Theory of Corner Reflectors with Unequal Faces," E. Kreyszig, AF 33(616)-2546, 1 Jul 57, (19:5), Unclassified, AD 139 026.

An investigation of those properties of corner reflectors which depend on the shape of the mirrors. Primary attention is given to determining the equivalent flat-plate echo area for arbitrary direction of incidence of a corner reflector whose sides are rectangular in shape, and to establishing the maximum value of that quantity. The work is kept in as general a form as practicable, however.

Initial attention is given to establishing the following result: for a triple reflection taking place in three mutually perpendicular quadrants of planes, the echo ray of an incident ray R lies in a straight line which is parallel to R and intersects the plane of incidence at a point P obtained by reflecting the point of incidence of R at the origin of the plane of incidence. Formulas are then obtained for the orthogonal projection of points on the corner reflector into a plane N normal to the incident beam, for all directions of incidence. The image of the boundary of the reflector in N is then found as a function of the direction of incidence. From this is derived the boundary of the equivalent flat-plate reflector, i.e., the boundary curve of the cross-section of the pencil of rays that are triply reflected; the method is independent of mirror shape.

At this point, attention is specialized to the reflector having rectangular sides. Formulas for equivalent echo area are derived. A technique for determining the maximum echo area is developed which is applicable to a general class of corner reflectors that includes the rectangular-sided reflector. For the latter, with sides of lengths A, B, and C, the result is:

$$A_{f,max} = 3ABC(A^2 + B^2C^2)^{-\frac{1}{2}} ,$$

which applies for an incident beam defined by direction angles

$$\phi = \arctan\,(C/A), \qquad \theta = \arctan\,(B/A).$$

OHIO STATE UNIVERSITY RESEARCH FOUNDATION, ANTENNA LABORATORY (CONT.)

5646 Report 601-23, "Comparison of Balance Point and Static Error Voltages of a Complex Target for Various Tracking Radar," L. Peters, Jr. and F. C. Weimer, AF 33(616)-2546, 31 Aug 57, (24:4), Unclassified, AD 162 713.

Four radar tracking systems were analyzed in an effort to determine which offered the greatest advantage, from a quasi-static viewpoint, in tracking a complex target. Expressions were developed and compared for the balance-point and error voltages for the following: (1) conical scan system; (2) four-lobe amplitude monopulse tracking system; (3) two-lobe phase-amplitude monopulse tracking system; and (4) four-lobe phase monopulse tracking system.

Results may be summarized as follows: (1) The conical scan system, the four-lobe monopulse system, and the "true" four-lobe amplitude system are equally accurate as tracking systems. (2) The separation of the antennas for the actual four-lobe amplitude monopulse should be minimized as much as possible to approximate the "true" four-lobe monopulse system. (3) The phase-amplitude monopulse system should not be used for tracking complex targets.

5647 Report 601-29, "Accuracy of Tracking Radar Systems," L. Peters, Jr., AF 33(616)-2546, 31 Dec 57, (131:24), Unclassified, AD 200 027.

The performance of various radar systems in tracking complex targets is analyzed. Equations for the balance point are obtained in terms of the amplitudes and phase of signals reflected from point scatterers and of scatterer positions. It is concluded that the conical-scan and phase-monopulse tracking systems are the most accurate. The amplitude-monopulse system is equally accurate if the separation between antennas is negligible; if not, an additional error is introduced. The phase amplitude-monopulse system introduces a cross-talk term, and should not be used.

5648 Report 662-36 (Final Report), "Antenna Phenomena Research," DA 36-039 SC-70174, 1 Nov 59, (31:81), Unclassified, AD 233 600.

Brief summaries are given for each of a number of specific technical investigations conducted under the subject contract. Among those described are a study on backscattering from a circular loop (see Abstract 2509) and backscattering from perfectly conducting spheroids of low eccentricity (see Abstract 2508). No detailed results are given.

5649 Report 667-17, "The Electromagnetic Theory of the Spherical Luneberg Lens," C. T. Tai, AF 33(616)-3353, 31 Aug 56, (25:19), Unclassified, AD 109 371.

The electromagnetic field in a radially stratified medium is treated in general and then applied specifically to the spherical Luneburg lens. The general expression for the electromagnetic field due to a dipole placed in the neighborhood of the lens is derived. The dipole was considered to be moved to the rim of the sphere; hence the condition corresponding to excitation of the Luneburg lens was obtained. The scattered field produced by the lens due to an incident plane wave is obtained by considering the dipole as being moved to infinity. A number of important formulas pertinent to the problem are given, along with a brief discussion about the solution to another class of stratified lenses.

Note: The 667 report series concerned an investigation entitled "Research on Antennas for Aircraft and Missiles."

OHIO STATE UNIVERSITY RESEARCH FOUNDATION, ANTENNA LABORATORY (CONT.)

5650 Report 667-33, "The Radiation and Back-Scattering Characteristics of a Traveling-Wave Antenna," J. N. Hines, J. A. McEntee, and R. W. St. Clair, AF 33(616)-3353, 15 Jul 57, (13:5), Unclassified, AD 144 731.

Investigation of the radiation and backscatter characteristics of an end-fire tapered-depth antenna, which was mounted in a metallic surface simulating a wing section. Scattering characteristics were determined as a function of the shape of the surface's leading edge; results are briefly tabulated.

5651 Report 667-49, "Scattering of Electromagnetic Waves by Turbulent Air," W. H. Peake, AF 33(616)-3353, 28 Feb 59, (61:30), Unclassified, AD 215 220 (DDC reference only).

(DDC) Contents include discussions of: properties of turbulent fluids; theory of scattering; relations between the statistical properties of the scattered radiation and those of the turbulent regime; and the general reception problem.

5652 Report 694-1, "An 8.66 MM CW Reflection Measuring System," G. Weiner, AF 33(616)-3649, 31 Oct 56, (53:17), Unclassified, AD 118 638.

Described is a CW radar-reflection system designed for measuring terrain return at a wavelength of 8.66 mm. System design is discussed in two major phases: design and test of the antenna, and assembly of the microwave components and instrumentation. Measured system-receiver response from calibrated scatterers was compared with that calculated and found to be in good agreement; measured antenna patterns also compared well with design predictions. Although the system performed according to design requirements, transmitter-receiver isolation limited measurement accuracy for some types of terrain. A suggested method for improving the isolation is included.

Note: The 694 report series deals with a program entitled "Terrain Investigations." Some of the reports are classified and abstracts are in other volumes of this bibliography.

5653 Report 694-3, "Simple Models of Radar Return from Terrain," W. H. Peake, AF 33(616)-3649, 10 Sep 57, (35:16), Unclassified, AD 147 067.

Four simple surface models of terrain are analyzed in terms of their prediction of the parameter γ, the radar cross-section normalized to the incidence area. The models are: very smooth surface, slightly rough surface (Rice, Abstract 967), random distribution of hemispheres (Twersky, Abstract 7428J), and layer of thin dielectric cylinders. Formulas are tabulated for horizontal polarization, and γ is plotted for the various models as a function of wavelength (0.1-320 cm), angle of incidence, and dielectric constant. The models are compared on the basis of their dependence on parameters of the radar, geometry, and terrain. In particular, any meaningful comparison between theory and experiment requires better information than is usually available on the complex dielectric constant and surface characteristics of the terrain.

5654 Report 694-5, "A Study of Ground Mapping Radar," R. L. Cosgriff, AF 33(616)-3649, 31 Dec 57, (31:-), Unclassified, AD 162 717.

The general problem of terrain mapping and radar displays is analyzed in rather vigorous mathematical style, supported by physical interpretations. The received rf signal is analyzed in terms of the nature of the return from one point target, which specifies a filter whose output has the same properties as the actual received signal. A received signal from a point source is represented by a single

OHIO STATE UNIVERSITY RESEARCH FOUNDATION, ANTENNA LABORATORY (CONT.)

5654 (Cont.)

impulse, and the return of a large number of reflectors by a series of impulses corresponding to a noise source. The receiver is represented by another filter with corresponding gain and a receiver noise input. This describes a linear system up to the detector.

Analysis of the detector output is described in terms of noise itself, terrain signal, and signal and noise. The display is considered as a single trace; the intensity along this trace is represented by the output of a filter. Average intensity when integrated is proportional to both terrain signal and noise signal.

5655 Report 694-9, "Electromagnetic Reflection Properties of Natural Surfaces with Applications to Design of Radars and Other Sensors (Terrain Handbook)," R. L. Cosgriff, W. H. Peake, and R. C. Taylor, AF 33(616)-3649, 1 Feb 59, (100:46), Unclassified, AD 216 418.

The problem of determining the characteristic terrain-return parameter γ ($\sigma^{\circ} = \gamma \sin \theta$, where θ is depression angle) is treated from both theoretical and experimental points of view, with emphasis on interpreting or "arranging" theory to provide meaningful experimental measurements for the design of radar systems. The range equation is expressed in terms of γ, with independent expressions describing terrain, geometry, and the system.

The CW Doppler terrain-measuring system is described and experimental data is presented in a set of 100 figures. Measured values of γ are given for smooth and vegetation-covered ground and for sea, with inclusion of the effects of snow, rain, and seasonal changes upon γ. Fundamental parameters are surface roughness, incidence angle, polarization, complex dielectric constant, and frequency (10, 15, and 30 Gc).

Note: This "Terrain Handbook" has been superseded by a later one available only by purchase from Ohio State, see Abstract 5658.

5656 Report 694-10, "Terrain Return Measurements at X, K_u, and K_a Band," R. C. Taylor, AF 33(616)-3649, 30 Apr 59, (15:2), Unclassified, AD 216 417.

Backscattered return from various types of terrain was measured at a range of 20 ft with a truck-mounted CW Doppler radar, and the average cross-section was determined as a function of incidence angle for frequencies of 10, 15.5, and 35 Gc. Results are expressed in terms of the parameter γ. Measurements were taken at incidence angles from 10° through 80°, are absolute in value, and are said to be accurate to $\pm$ 1 dB. Both horizontal and vertical polarizations were used. Surfaces investigated included smooth and rough concrete, smooth and rough asphalt, gravel, cinders, and oil. With vertical polarization, γ shows a moderate tendency to increase as the incidence becomes more nearly normal to the terrain, but as the surface becomes rough, γ becomes independent of incidence angle. Horizontal polarization may give as much as 15 dB lower return than vertical, the difference being more noticeable for smooth surfaces and for grazing angles. Vegetation-covered terrain was found to undergo highly significant seasonal changes in γ, and all surfaces show marked change when covered by water or snow.

OHIO STATE UNIVERSITY RESEARCH FOUNDATION, ANTENNA LABORATORY (CONT.)

5657 Report 694-12, "Theory of Radar Return from Terrain," W. H. Peake, AF 33(616)-3649, 30 Apr 59, (25:10), Unclassified, AD 216 416.

Two theoretical expressions were developed for predicting the backscattering cross-section of terrain. One of the models is applicable to roadways and similar continuous, relatively smooth surfaces and gives the backscattered return in terms of the roughness, height correlation function, and complex dielectric constant of the surface. The other model, which is applicable to grass or other similar cylindrical vegetation, gives the return as a function of the number, size, and complex dielectric constant of the cylindrical scatterers.

The standard perturbation method was used to develop the model for roadways and similar surfaces. Calculated and measured data for asphalt and concrete roadways are presented as γ vs. θ ($\gamma = \sigma^{\circ}/\sin\theta$ and θ is grazing angle) for both horizontal and vertical polarization at X-band and K_a-band. The measured and calculated data are in very good agreement.

For surfaces covered with grass-like vegetation, it was assumed that individual blades or stems scatter like long, thin, lossy cylinders, distributed randomly over the surface with some prescribed probability distribution for the direction of the cylinder axis. The terrain return was then calculated by the single-scattering approximation. Measured and theoretical results for 3-inch oats, 1- and 2-inch green grass, 12-inch wheat stubble, 1- and 2-inch dry grass, and 4-inch wet grass and soybean stubble are compared at X-band and K_a-band frequencies for both horizontal and vertical polarization. The results did not compare as favorably as did those for smooth surfaces.

5658 Bulletin 181, "Terrain Scattering Properties for Sensor System Design (Terrain Handbook II)," R. L. Cosgriff, W. H. Peake, and R. C. Taylor, AF 33(616)-3649, May 60, (118:60), Unclassified, AD 251 913 (DDC reference only).

The original "Terrain Handbook" (see Abstract 5655) issued in 1959 has been revised and expanded. Sections have been added on the relation between scattering properties of a surface and its apparent temperature, and the bistatic reflection properties of terrain. The current edition thus provides basic data on the back-scattered radar return from a variety of natural and man-made surfaces at X-band, K_u-band, and K_a-band for incidence angles between 10° and 80°, and for both vertical and horizontal polarizations. Two theoretical models for terrain return, one applicable to slightly rough surfaces, and the other to certain kinds of vegetation, are developed. These models, together with the data, are used to clarify the roles of surface roughness, dielectric constant, frequency, incidence angle, and polarization, and to explain the observed effects of season, precipitation, etc., on radar return. The relation between the emissivity of terrain, and its complete (bistatic) scattering pattern is derived, and some bistatic scattering measurements on grass and asphalt surfaces at L-band are reported. A spectral approach to radar system operation, which can conveniently take account of both the average and statistical properties of terrain and the nonlinear characteristics of screen and observer, is described, and used to provide formulas for the performance capabilities of PPI and B-Scope systems.

Note: DDC does not furnish copies of this document; it may be obtained from the Engineering Experiment Station, College of Engineering, The Ohio State University, Columbus, for $3.00 per copy.

OHIO STATE UNIVERSITY RESEARCH FOUNDATION, ANTENNA LABORATORY (CONT.)

5659 Report 722-16 (RADC-TN-60-57), "The Diffraction by a Uniform Grating of Cylinders and Its Effect on the Pointing Accuracy of a Monopulse Antenna," S. N. C. Chen, AF 30(602)-1620, 15 Feb 60, (78:14), Unclassified, AD 235 260.

An approximation for diffraction of a plane wave by a uniform grating of cylinders is used to estimate the pointing accuracy of a monopulse antenna. The approximation makes use of the fact that the electric field scattered by an infinitely long cylinder of small diameter can be approximated by the radiation from an infinitely long linear element and, therefore, considering only the scattered field, the cylinder could be replaced by a linear current element. The grating considered is composed of perfectly conducting circular cylinders about $\lambda/10$ in diameter spaced about 3λ to 4λ apart. Some conclusions are: (1) For a normally incident plane wave, the current magnitude is maximum when grating spacing is an odd number of half wavelengths and minimum when the spacing is an integral number of wavelengths. (2) Maximum power transmission occurs when the grating spacing is an integral number of wavelengths, minimum when the number of half wavelengths is odd.

5660 Report 768-1, "The Significance of Phase in Microwave Measurement of Polarization Phenomena," J. R. Copeland, AF 33(616)-5078, 1 Jun 58, (68:9), Unclassified, AD 162 719.

Relative-phase measurements are discussed as a means both of determining wave polarization and of classifying radar targets according to their polarization properties. It is shown that three relative-phase measurements using the same antenna probe are sufficient to give a unique solution for the polarization of an incoming plane wave. The more conventional amplitude-measurement procedure requires a fourth measurement, using a different probe antenna, to resolve ambiguities.

The procedure presented for the classification of radar targets makes use of the amplitude and relative phase of the backscattered signal. The general equation which was derived for the received voltage in a rotating, linearly polarized radar antenna takes on several characteristic forms for certain classes of targets; analysis was based on a complex plot of the derived voltage. It is shown that the polarization-transforming properties of any target may be represented by a sphere and a so-called linear target (e.g., a thin wire); illustrative curves are included. The representation may be made up of a sphere plus a thin-wire target for targets which have a plane of symmetry contained in the line of sight.

Note: The 768 report series deals with an investigation entitled "Techniques for Enhancement of Radar Reflection Characteristics."

5661 Report 768-2, "Some Methods of Obtaining Circular Polarization Over a Broad Band of Frequencies by the Use of Birefringent Plates," R. K. Long, AF 33(616)-5078, 1 Jun 58, Unclassified, AD 203 827.

Note: This report was not obtained.

5662 Report 768-3, "Polarization Properties of Reactive Wall Corner Reflectors," E. M. Kennaugh and H. W. Baeumler, AF 33(616)-5078, 1 Jun 58, (40:3), Unclassified, AD 231 471.

Normal corner reflectors, in which all three walls are good conductors, possess the polarization properties of a flat conducting sheet, and hence give no echo enhancement when used against circularly polarized radars. This report

OHIO STATE UNIVERSITY RESEARCH FOUNDATION, ANTENNA LABORATORY (CONT.)

5662 (Cont.)

examines more general corner reflectors in which the polarization properties of the reflector can be controlled through the reflection properties of the walls. General formulas are developed for the circularly polarized response of a general triple-bounce corner reflector, and then specialized to specific cases. The polarization properties of reactive walls comprising layers of dielectric sheets on a reflecting wall are determined. Experimentally measured circularly polarized response is shown for a corner reflector with one wall modified by a dielectric sheet spaced from the reflecting surface by a variable air gap.

5663 Report 768-4, "Design of Corner Reflectors as Bistatic Radar Enhancement Devices," L. Peters, Jr., AF 33(616)-5078, 1 Apr 59, (7:3), Unclassified, AD 216 415.

The design of triple-bounce corner reflectors for use in shaping the bistatic echo-area patterns of targets is briefly discussed, and an equation is developed which may be used to obtain approximate patterns as a function of bistatic angle. Also included are a summary of design procedures, design curves, and basic limitations for the method. Detailed discussions on the derivation of this technique are presented in Report 768-5 (see next abstract).

5664 Report 768-5, "Theory of Corner Reflectors as Bistatic Radar Enhancement Devices," L. Peters, Jr., AF 33(616)-5078, 30 May 59, (69:9), Unclassified, AD 220 542.

A technique is described for designing corner reflectors to achieve an arbitrary rate of echo-area decay as a function of bistatic angle; its intended application was to enhance the bistatic echo area of target drones. It is shown that the bistatic angle between a target aircraft and a missile launched from an intercept aircraft increases as the missile approaches the collision point; moreover it is shown that if the radar receiver sensitivity is assumed to be fixed, then the bistatic echo area can be permitted to decrease as bistatic angle increases. A design is given for a bistatic enhancement device using a rectangular aperture. The method is applied to the dihedral corner reflector and then extended to the triple-bounce corner reflector. For certain ranges of bistatic angle, experimental echo-area patterns for a corner reflector were in good agreement with predicted values. (See also previous abstract.)

5665 Report 768-6, "Theory of Spherical Reflectors for Bistatic Radar Enhancement," L. Peters, Jr., AF 33(616)-5078, 31 Jul 59, (22:10), Unclassified, AD 228 273.

This report discusses techniques to be used in designing spherical devices for enhancing bistatic echo area. Far-field patterns were obtained under the assumption that these devices may be represented by a planar aperture with either quadratic or linear distribution of radial phase. It is shown that these far fields may be approximated by a pattern having logarithmic decay as a function of bistatic angle. One design procedure relates the rate of decay to parameters of the enhancement device. Also included are appendices on the derivation of aperture distributions and the evaluation of diffraction integrals.

Note: Report 768-7 is Confidential.

5666 Report 768-8, "The Luneberg Reflector for Bistatic Radar Enhancement," S. T. Bobey, Jr., AF 33(616)-5078, 15 Aug 59, (42:5), Unclassified, AD 231 472.

OHIO STATE UNIVERSITY RESEARCH FOUNDATION, ANTENNA LABORATORY (CONT.)

5666 (Cont.)

The use of the Luneburg reflector as a bistatic enhancement device was investigated at X-band frequencies. First, the phase distribution in the aperture of a defocused Luneburg reflector is calculated for several reflector spacings. From these aperture distributions, the integral relationship developed in Report 768-6 (preceding abstract) is used to obtain the reradiation patterns which are presented as normalized patterns for various values of β (the phase at the edge of the aperture relative to the aperture center). A design procedure is given for a defocused Luneburg reflector to be used in approximating a desired set of bistatic conditions. To verify the process, experimental bistatic measurements were made of an 18-inch Luneburg reflector at 10.0 Gc with both vertical and horizontal polarizations, for various spacings of the reflector and for bistatic angles from 2° to 20°. A total of 40 patterns are presented. It was concluded that commercially available Luneburg reflectors can be used for enhancing bistatic echo area at X-band frequencies, provided the desired bistatic echo-area-pattern variation can be approximated by $\epsilon^{-2\gamma\theta}$ (γ is a constant, θ the bistatic angle).

5667 Report 768-9, "Geometrical Optics Approximations for the Effects of Shock Waves on Spherical Geometrics," R. B. Green, AF 33(616)-5078, 15 Aug 59, (31:4), Unclassified, AD 231 915.

Scatter effects of plasma shock waves, under circumstances easily obtained in practice, are shown to significantly alter the radar echo area of the object producing them and, in many cases, to completely determine the observed echo area. It is shown that the radar return from a very fast-moving object can be determined from its associated shock wave; the radar return is independent of intrinsic radar properties of the object when at rest. To illustrate shock-wave effects, the echo area at 18.0 Gc was determined for a sphere of radius 1 m which was travelling through the atmosphere at an altitude of 161,000 ft over a range of speeds from Mach 10 to Mach 15. The plasma distribution about a sphere was assumed to be the same as for the stagnation point, and only approximations based on geometrical optics were considered. Bistatic echo areas were studied, along with expressions for backscatter from the dielectric sphere and from the metallic sphere with a homogeneous shell. An appendix treats a system suitable for laboratory modeling of configurations involving shock waves.

5668 Report 768-10 (Final Engineering Report), "Techniques for Enhancement of Radar Reflection Characteristics," AF 33(616)-5078, 16 Aug 59, (14:10), Unclassified, AD 231 934.

This is the final report in a series of ten which describe a program devoted to studying techniques for controlling polarization and bistatic characteristics of radar echo-enhancement devices. Some of the more important findings during the program are summarized and references are made to individual reports (see preceding abstracts). Some conclusions from the overall program are as follows: (1) Adequate same-sense circular-polarization response of corner reflectors can be obtained over specified frequency bands through the use of dielectric-sheet inserts without significantly deteriorating performance against linearly polarized radars. (2) Corner reflectors in which the walls deviate slightly from the condition of mutual perpendicularity are satisfactory bistatic devices. (3) Luneburg lenses can also be made acceptable bistatic reflectors by introducing a slight error, in this case moving the reflector to some radius other than the focal radius.

OHIO STATE UNIVERSITY RESEARCH FOUNDATION, ANTENNA LABORATORY (CONT.)

5669 Report 777-2 (Revised), "Revised Report on Modulation of the Plane-Wave Reflection Coefficient of a Semi-Infinite Dielectric Sheet Through Induced Conductivity," W. E. Bulman, AF 33(616)-5341, 1 May 59, (9:5), Unclassified, AD 219 696.

Reflection from air-semiconductor interfaces was examined theoretically for possible modulation purposes. Magnitude and phase of the reflection coefficient are calculated for relative dielectric constants of 2, 4, 9, and 19, and for ratios σ/f from 10^{-3} to 10^{2}, where σ is the conductivity of the semiconductor, and f is frequency in Gc. It was concluded that four types of modulation appear interesting: (1) phase modulation, from nearly perfect dielectrics without appreciable change in amplitude; (2) switching of phase and magnitude from values for a dielectric to those for a nearly perfect conductor; (3) variation of phase of reflections from conducting materials without appreciable change in magnitude of the reflection coefficient; and (4) amplitude modulation of the reflection coefficient with attendant phase modulation.

Note: The 777 report series deals with a program bearing the title "Radar Reflection Studies and Techniques," which was concerned with the problem of measuring flare spots in the backscatter echo-area patterns of complex targets, and of locating the structural features from which they arise. Many of the reports are classified and abstracts are in other volumes of this bibliography.

5670 Report 777-3, "A Modulating Window Technique for the Measurement of the Microwave Scattering from Complex Objects," C. W. Pittman, AF 33(616)-5341, 1 Jun 58, (42:9), Unclassified, AD 162 718.

Theoretical analysis of a measurement technique that could prove useful for obtaining scattering data from flare spots on a complex target. The method employs a window comprising a small air-core dielectric sandwich panel, one membrane of which vibrates about its equilibrium position, phase-modulating all fields passing through the window. By placing the window in front of a reflecting body, the signal scattered from the body through the window will be phase-modulated and can be detected in the presence of other unmodulated signals. It is concluded that the sandwich slabs should be made of a low-loss dielectric of the highest dielectric constant obtainable and that the slabs should be an odd number of quarter wavelengths thick. Included are appendices on the derivation of expressions for the reflection and transmission coefficients of a lossless dielectric sandwich, and on the results of an experiment to validate these expressions.

5671 Report 777-4, "On Tracking Radar Systems and the Target Phase Center," D. E. Lewis, AF 33(616)-5341, 15 Sep 58, (11:5), Unclassified, AD 211 187.

A brief discussion of the relation between the balance-point of a radar target and the phase of the backscattered signal. Radar balance-point is defined as the point on a target that either a conical-scan or a phase-monopulse tracking radar would track if the servo system were infinitely fast. Previous work on this subject is reviewed. It is concluded that conical-scan and phase-monopulse radar tracking systems do point in the direction of the "phase center" of a target and that techniques of this type could have practical application in determining reflection characteristics of aircraft.

OHIO STATE UNIVERSITY RESEARCH FOUNDATION, ANTENNA LABORATORY (CONT.)

5672 Report 777-6, "Utilization of Photoconductivity in Electromagnetics," W. E. Bulman, AF 33(616)-5341, 30 Nov 58, Unclassified, AD 235 537 formerly AD 304 210.

Note: This report was not obtained.

5673 Report 777-14, "Flare Spot Determination by Use of Photoconductive Panels," R. B. Green, AF 33(616)-5341, 31 May 59, (62:9), Unclassified, AD 218 446.

Description of a technique for determining the location and magnitude of flare spots on radar targets. The technique is very similar to that described by Pittman (see Abstract 5670 above), except that a photoconductive panel is employed instead of an air-core dielectric sandwich. A coherent detection system is required, such that the receiver responds only to signals modulated at the frequency of the panel modulation; hence, all return signal measured at the detector output represents that portion of the target illuminated through the panel. From a practical point of view, the photoconductive panel is far superior to others, since its physical properties may be changed simply by varying the light intensity on it.

5674 Report 777-15, "A Free Space Dielectric Measuring System and Its Application to the Measurement of Some Properties of Photoconductive Films," B. Potts, AF 33(616)-5341, 15 Jul 59, (18:11), Unclassified, AD 225 847.

Outline of procedures for measuring properties of photoconductive films, useful in the modulating window technique (see preceding abstract) for locating and measuring flare spots on complex targets.

5675 Report 777-17, "Reflection, Transmission, and Absorption of Plane Electromagnetic Waves by Lossy Dielectric Panels," H. W. Baeumler, AF 33(616)-5341, 31 Aug 60, (23:2), Unclassified, AD 244 536.

Calculations of transmission and reflection coefficients for several photoconductive-panel designs as functions of conductivity, angle of incidence, and polarization. Variations in these coefficients produced by changes in conductivity are given for (1) thin panels (thickness 0.004λ), (2) half-wave panels, and (3) panels 0.45λ thick. It is shown that variation in the magnitude of the transmission coefficient can exceed that of the reflection coefficient by factors of approximately 2.5 and 3.5 for (2) and (3), respectively, with TE polarization at incidence angles within 30° of normal. With TM polarization, these factors vary with angle of incidence, ranging from 2.5 to 3.5 for (2) and from 3.5 to 5.5 for (3).

5676 Report 777-19, "Echo Area Properties of Bodies Due to Certain Traveling-Wave Modes," L. Peters, Jr., AF 33(616)-5341, 18 May 60, (16:8), Unclassified, AD 239 936.

Presentation of a new technique for calculating the echo area of long, thin bodies, based on the concept of a surface traveling-wave mode. Echo area due to this mode can be controlled by altering the relative phase velocity of the traveling wave, which may be done by changing the curvature of the body, using a dielectric coating, or corrugating the surface. These last two methods can introduce new modes, resulting in a large end-fire echo area. Reasonable agreement is found with experimental results. Application is made to both rods and thin ogives.

OHIO STATE UNIVERSITY RESEARCH FOUNDATION, ANTENNA LABORATORY (CONT.)

5677 Report 777-22, "A Sensitive, Coherent, X-Band Echo-Measuring System for Special Applications," R. W. Crawford and S. A. Redick, AF 33(616)-5341, 31 Oct 60, (23:9), Unclassified, AD 251 434.

Description of an instrumentation scheme for use with the modulated-panel technique (see Abstracts 5673 and 5670 above) of flare-spot location and measurement. The scheme concerns the coherent-detection equipment, and involves feeding the outputs of a balanced coherent detector to a bandpass audio-difference amplifier. The high-gain audio amplifier is tuned to the panel modulation frequency and drives a logarithmic recorder. An appendix describes an alternate coherent detection scheme which detects both phase and amplitude.

5678 Report 786-3, "On the Theory of Scattering by Dielectric and Metal Objects," J. H. Richmond, AF 33(616)-5410, 1 Apr 58, (43:10), Unclassified, AD 161 666.

Several antenna reciprocity theorems are derived and presented along with integral relations between antenna fields and terminal currents. It is noted that a choice can be made between surface and volume integrals, that the total field can be replaced by the scattered field or a traveling-wave component, and also that a simplification occurs when a plane integration surface is chosen. Expressions are presented for the fields of an antenna in terms of integrals using Green's functions. The impedance of an antenna in the presence of an obstacle is derived; scattering by a truncated object is expressed as a correction term to be added to the scattering by the corresponding complete object. A generalization of Babinet's principle is given which permits consideration of scattering by objects which are not plane, perfectly conducting, or thin.

5679 Report 786-20, "Electromagnetic Effects of Shock Waves Near the Stagnation Point of a Hypersonic Missile," R. K. Long, AF 33(616)-5410, 5 Mar 59, (21:6), Unclassified, AD 213 883.

Procedures are shown for computing the electromagnetic effects of the shock-wave ionized plasma at the nose of a hypersonic missile. Particular attention is given to typical speeds and altitudes for air-to-air and surface-to-air missiles. Graphs of electron and air-particle densities vs. missile speed are presented for altitudes of 53,000, 102,000, 161,000, and 220,000 feet. It is concluded that severe attenuation of radar signals will occur for wavelengths as short as 8.6 mm; however, for missile velocities below Mach 10, the effects of ionization on X-band or higher frequencies should be minor.

5680 Report 786-29, "Memorandum on Electromagnetic Properties of the Hypersonic Plasma Sheath," W. S. C. Chang, AF 33(616)-5410, 30 Jun 60, (-:47), Unclassified, AD 240 445.

(BD-3251) Space vehicles are surrounded by a dense plasma sheath of dissociated, high-temperature air during atmospheric re-entry. Transmission and reflection of electromagnetic signals are severely affected by this plasma. In this report, an attempt is made to analyze, both theoretically (macroscopically and microscopically) and experimentally, the hypersonic plasma sheath from five points of view: (1) conductivity and permittivity of plasma for weak signals; (2) nonlinear properties of plasma for moderately strong signals and the breakdown process of very strong signals; (3) transmission, reflection, and diffraction characteristics of the sheath; (4) the noise and plasma radiations; and (5) radar echo areas and the Doppler shifts of the plasma. Because of the lack of experimental data and the complexity of hypersonic flight conditions, the analyses presented are incomplete.

OHIO STATE UNIVERSITY RESEARCH FOUNDATION, ANTENNA LABORATORY (CONT.)

5681 Report 786-31, "The Numerical Evaluation of Radiation Integrals," J. H. Richmond, AF 33(616)-5410, 31 Aug 60, Unclassified.

Note: This report was not obtained.

5682 Report 792-1, "An Automatic Strip Chart-to-Punched Card Data Converter," R. B. Lackey, AF 33(616)-5398, 1 May 58, (13:1), Unclassified, AD 201 191.

Description of an automatic data-reduction system intended to process RCS measurement data. The system utilizes a chart-scanning principle to quantize the amplitude of a recorded signal and punch each reading on standard five-channel teletype tape. Resolution of the chart scanner is 50 counts for a full-scale vertical reading, scanning rate is approximately 200 scans per minute, and the chart records 50 scans per inch.

5683 Report 792-2, "A System for the High-Speed Recording of Radar Echo Patterns and for the Transfer of the Data to Punched Tape," R. Caldecott and J. Q. Burgess, AF 33(616)-5398, 15 Dec 58, (16:3), Unclassified, AD 211 719.

Description of development of a high-speed RCS measurement recorder system for use with a conventional K-band radar. A logarithmic output from the receiver is fed to a high-speed pen recorder, which forms an open-loop servo system to record radar echoes. The recorder chart is scanned by an optical converter (preceding abstract) which records the information on punched tape.

5684 Report 792-3 (Internal Report), "A Memorandum on Logarithmic Devices," R. W. Crawford, AF 33(616)-5398, 15 Dec 58, Unclassified.

Note: This report was not obtained.

5685 Report 792-4, "A Time Gate for Echo-Measuring Radar Installation," J. Bacon and J. Q. Burgess, AF 33(616)-5398, 15 Jan 59, Unclassified, AD 212 351.

Note: This report was not obtained.

5686 Report 792-5 (Final Engineering Report), "Techniques for Echo Area Determination," AF 33(616)-5398, 1 Feb 59, (17:11), Unclassified, AD 211 860.

The research program summarized here studied methods to improve the accuracy and utility of techniques for measuring radar cross-sections of aircraft and missiles. The program was active from 1 November 1957 to 31 January 1959. Various aspects of static-model echo measurement were investigated, including techniques for generating millimeter-wavelength radiation, improved instrumentation for data recording and data reduction, and the design of low-reflection model-support towers. In addition, several problems associated with the determination of satellite and missile echo areas were studied experimentally.

5687 Report 827-2 (AFCRC-TN-59-582), "Representations of a Scattering Pattern by a Collection of Induced Dipole Sources," R. Tsu, AF 19(604)-3501, 30 Jun 59, (18:1), Unclassified, AD 226 996.

It is known that scattering from a small sphere can be represented by a pair of electric and magnetic dipoles located at the center of the sphere. The range of applicability of this model as well as the possible extension of it to a larger sphere by spacing the dipoles was examined. More complicated models based on distributions of dipoles and collections of multipoles were also investigated. Induced electric and magnetic dipole pairs inside the sphere were used, as well as

5687 (Cont.)

additional dipoles on or slightly inside the sphere surface. When the amplitudes of these dipole surfaces were adjusted to give correct value of scattering in three directions, for two polarizations of the incident wave, the resulting scattering patterns showed fairly good agreement at intermediate angles for spheres less than 1.7λ in circumference but poor agreement for larger spheres.

Note: The 827 report series concerns an investigation entitled "Bi-static Reflection Characteristics." Some of the reports are classified and abstracts are in other volumes of this bibliography.

5688 Report 827-4 (AFCRC-TN-59-557), "Approximate Solutions to Scattering Problems by Multipole Matching," E. M. Kennaugh and R. Tsu, AF 19(604)-3501, 24 Jul 59, (25:6), Unclassified, AD 228 571.

Some initial results are presented of a method for approximating the solution to scattering problems. Through the use of field matching at an increasing number of points on the surface of the scatterer, a general method was developed for obtaining successively higher order approximations to the solution. For the special cases considered, comparisons of approximate values with exact measured and calculated values showed good agreement. The multipole approximation appears useful for approximate solutions to scattering problems, especially in the resonance region. The method is sufficiently general to handle conducting bodies of arbitrary shape, and could be programmed for machine computation. An inherent advantage of the method is that estimates of the error in a given approximation can be obtained by comparing matching and exact fields on the scatterer surface. (See also next abstract.)

5689 Report 827-5 (AFCRC-TN-60-115), "Multipole Field Expansions and Their Use in Approximate Solutions of Electromagnetic Scattering Problems," E. M. Kennaugh, AF 19(604)-3501, 1 Nov 59, (72:41), Unclassified, AD 231 874.

Representation of electromagnetic fields by multipole expansions and their use in the approximate solution of scattering problems are discussed; in particular, the problem of representing solutions of Maxwell's equations in homogeneous isotropic regions is considered. Several methods are described for obtaining multipole expansions from a knowledge either of the source distribution (or the values of the tangential field) over a closed surface, or of the field components and all their derivatives at a single point.

Application of multipole fields to the approximate solution of single-body scattering problems is also discussed. A method is described for obtaining the best approximation to a match of tangential-field components at the scatterer surface. For the case of a perfectly conducting scatterer, it is shown that the convergence of field-matching techniques can be verified and a bound on the mean square error in the scattered field obtained if a certain inequality can be derived; this was done for a spherical scattering surface.

Application of these techniques is illustrated for perfectly conducting prolate and oblate spheroids. First- and second-order solutions were obtained for a prolate spheroid having axes of 0.35λ and 0.28λ and for an oblate spheroid with axes of 0.42λ and 0.35λ, both being illuminated by a plane wave incident along the axis of symmetry. Comparison of experimental and calculated cross-sections at angles of 30°, 60°, 90° and 120° from the axis showed the approximations to be accurate to within 1 dB.

OHIO STATE UNIVERSITY RESEARCH FOUNDATION, ANTENNA LABORATORY (CONT.)

5690 Report 827-6 (AFCRC-TN-60-102), "Extension of the Physical Optics Approximation to Small Bodies," J. Eberle, AF 19(604)-3501, 1 Nov 59, (18:4), Unclassified, AD 231 996.

A number of methods are discussed for correcting and adjusting the physical-optics approximate solution to the problem of scattering by perfect conductors in order to obtain better results in the resonance and long-wavelength regions. These methods are applied to backscattering by spheres and by a spheroid of 10:1 axial ratio. Two fundamental objections to the physical-optics approximation are that it does not satisfy reciprocity or predict polarization-dependent effects in backscattering. It is concluded that the physical-optics approximation can be improved in the long-wavelength region by using simple correction terms; the accuracy of the corrected approximation in the short-wavelength and resonant regions leaves much to be desired.

5691 Report 827-7 (Final Engineering Report; AFCRC-TR-60-116), "Bistatic Reflection Characteristics," AF 19(604)-3501, 1 Nov 59, (10:5), Unclassified, AD 234 488.

This final report in a series on bistatic reflection characteristics summarizes the unclassified research performed under the contract from 1 May 1958 to 31 October 1959. Briefly described are several analytical methods for approximating radar echo area which were investigated during this period; also given are references to the more detailed reports.

5692 Report 889-7, "On the Detection of Artificial Earth Satellites," T. G. Hame, AF 33(616)-6137, 16 Oct 59, (-:11), Unclassified, AD 232 370.

(BD-1358) Topics include scattering from satellite-induced ionization and WWV recordings at 10 Mc.

5693 Report 889-8 (Final Engineering Report), "Reflection Characteristics of High-Velocity Aerial Targets," AF 33(616)-6137, 16 Nov 59, (18:26), Unclassified, AD 232 379.

This final report summarizes research on the characteristics of the upper ionosphere performed by monitoring signals from various satellites and WWV signals reflected from the ionosphere; details of the investigation were presented in other reports. Brief description is given of the monitoring equipment used in the investigation, including its nine antenna systems. Faraday rotation was theoretically analyzed and equations were developed to routinely solve for the electron density. Known effects were separated from the data collected, and electron density determined for previously undetermined heights. For certain times, electron-density profiles were obtained for the region above the F_2-layer maximum to a height of 1500 km. The use of millimeter-wavelength radiation to determine the echo area of large bodies is briefly treated.

5694 Interim Engineering Reports, "Study of Thermal Microwave and Radar Reconnaissance Problems and Applications, AF 33(616)-6158, Unclassified. (No automatic release to Foreign Nationals, except Report 898-13.)

Report	Date	AD No.
898-5	1 Oct 59	245 122L
898-6	1 Jan 60	245 123L
898-7	1 Apr 60	245 124L
898-13	1 Apr 61	258 507

OHIO STATE UNIVERSITY RESEARCH FOUNDATION, ANTENNA LABORATORY (CONT.)

5694 (Cont.)

These documents provide only very brief summaries of progress on the program which is reported in detail in other reports (see following abstracts). Program emphasis was on radiometry, and these interim reports contain almost no material pertinent to reflectivity.

5695 Report 898-2, "The Interaction of Electromagnetic Waves with Some Natural Surfaces," W. H. Peake, AF 33(616)-6158, 30 May 59, (103:38), Unclassified, AD 417 869.

Theory is developed for scattering from terrain and similar non-uniform surfaces. An effort is made to develop surface models that are simple enough to permit the scattering problem to be solved with reasonable accuracy, but still bear a close resemblance to the actual surface under consideration. To begin, the scattering coefficients are defined for a general surface, and their relationships with the backscattering coefficient, the absorption coefficient, and the albedo are derived.

Scattering coefficients are worked out in detail for two models, one applicable to slightly rough, continuous surfaces, and the other to surfaces covered with vegetation in the form of long, thin lossy cylinders. Results are compared with experimental results for backscatter from terrain. The theory is also applied to the problem of emission from the surface (radiometry). A 5-page appendix extends the results of S. O. Rice ("Reflection of Electromagnetic Waves by Slightly Rough Surfaces," The Theory of Electromagnetic Waves (Symposium), Interscience, 1951) for horizontal polarization to the case of vertical polarization.

5696 Report 898-9, "Analysis of Radar Return from Random Surfaces Relative to Motion between Surface and Radar," R. L. Cosgriff, AF 33(616)-6158, 15 Sep 60, (14:4), Unclassified, AD 409 891.

Approximations are derived for both CW and pulsed cases for the spectra of radar return from idealized terrain comprising a collection of random scatterers. An approximation is first obtained for the spectrum of the return from a single scatterer moving through the beam pattern of a CW radar, and this is extended to a collection of scatterers. The spectrum in the pulsed case is shown to be banded, with each band similar to that of the single band in the CW case. It is noted that a comb-type IF filter reduces the effective beamwidth by discriminating against those reflectors which are more removed from the center of the beam on the basis of their greater Doppler shift (relative to the average shift for the beam).

5697 Report 898-10 (Final Engineering Report, Vol. I), "Study of Thermal Microwave and Radar Reconnaissance Problems and Applications," AF 33(616)-6158, 1 Jul 60, (29:10), Unclassified, AD 250 363L. (No automatic release to Foreign Nationals.)

An investigation designed to provide basic data for analyzing various microwave radiometer systems and evaluating their effectiveness. It was determined that the apparent temperature of many terrain surfaces can be calculated in terms of two surface models whose parameters may be found from scattering data. Bistatic measurements were made for several surfaces, both to validate the models and to obtain previously unmeasured scattering cross-sections and reflection coefficients. Measurements were made at a frequency of 1150 Mc for various types of terrain

5697 (Cont.)

including asphalt roadway, 2-inch grass, and soybeans. Bistatic angle varied from 0° to 180°, while grazing angle varied from 6° to 30°. Representative data obtained from these targets are presented in plots relating bistatic cross-section to that for direct transmission.

Results show that terrain covered with short vegetation and such man-made surfaces as roads exhibit the general characteristics of "smooth surfaces," i.e., surfaces for which most of incident energy is reflected in the forward direction at approximately the specular angle. Polarization effects were very pronounced, horizontal polarization producing the greatest specular component of incident energy in the forward direction.

5698 Report 903-17 (Final Engineering Report, Vol. II, Part II), "Luneberg Lens Survey," R. C. Rudduck and C. H. Walter, AF 33(616)-6211, 1 Dec 60, (114:73), Unclassified, AD 263 853.

Existing Luneburg lenses are surveyed and the theory is developed on the basis of optical theory. The accuracy of the theory is sufficient to describe ray paths in the microwave region. In general the theory is discussed from a two-dimensional viewpoint, i.e., the ray paths are described on a surface of revolution. The lenses are grouped into classes according to their refraction properties. Methods of varying the refractive index of both two- and three-dimensional structures are discussed in detail, along with index and contour variations for particular electromagnetic properties.

Note: The 903 report series deals with an investigation entitled "Research on Electronic Reconnaissance Antennas."

5699 Report 903-27 (Interim Engineering Report), "Research on Electronic Reconnaissance Antennas," AF 33(616)-6211, 1 Jun 62, (27:4), Unclassified, AD 282 652.

This program investigated the feasibility of controlling echo area of simple objects by introducing terminals and loading them with active elements. Preliminary X-band scattering measurements made of a flat plate $\lambda/2$ by $3\lambda/4$, both with and without a slot $\lambda/10$ by $\lambda/2$, indicated that broadside cross-section was reduced 13 dB by introducing the slot. (See also next abstract.)

5700 Report 903-28 (Interim Engineering Report), "Research on Electronic Reconnaissance Antennas," AF 33(616)-6211, 1 Sep 62, (21:1), Unclassified, AD 286 338.

Brief comments are made on efforts to control the echo-area of two T-bar slot antennas by integrating them with a hybrid parametric amplifier (hybrid T-bar slot antennafier).

5701 Report 903-29 (Final Engineering Report), "Research on Electronic Reconnaissance Antennas," AF 33(616)-6211, 31 Dec 62, (60:12), Unclassified, AD 298 557.

Summary of research on topics relating to the design of integrated antennas and of circuitry. Antennafiers, antennaverters, and antennamitters are discussed briefly; these are unified systems wherein various types of broad- and narrow-band antennas are incorporated with amplifiers, converters, and transmitters respectively. Also described are various circuit components. Applications of integrated

OHIO STATE UNIVERSITY RESEARCH FOUNDATION, ANTENNA LABORATORY (CONT.)

5701 (Cont.)

design principles to radar-echo-area control were considered, and measurements of a hybrid-coupled parametric amplifier and orthogonal T-bar slot antenna combination are presented. Also described is the 420-Mc CW radar system used for these measurements.

5702 Report 903-30, "Antennafiers for Echo Area Control," J. R. Copeland, W. J. Robertson, R. B. Green, and S. Mikuteit, AF 33(616)-6211, 15 Dec 62, (12:-), Unclassified, AD 292 979.

The hybrid-coupled parametric amplifier described here was integrated with a pair of orthogonal T-bar slot antennas in a ground plane in such a way that a signal arriving through either antenna was amplified and re-radiated from the other. The system operated in the VHF-UHF frequency bands. Echo-area measurements made with the system are presented, and the general process of controlling echo area with integrated antenna-active-element systems (antennafiers) is discussed. Also mentioned are a few applications in the fields of radar enhancement and camouflage, passive or pseudo-passive satellite communications, and ground-based repeaters.

5703 Report 925-1 (RADC-TN-60-151), "The Nose-On Echo Area of Axially Symmetric Thin Bodies Having Sharp Apices," S. Adachi, AF 30(602)-2042, 31 Mar 60, (18:5), Unclassified, AD 240 851.

The backscatter cross-section along the symmetry axis of finite and semi-infinite bodies of revolution is derived by a variational technique. Only gradual tapers are treated, i.e., all tangents in a plane which includes the axis of revolution intersect this axis at small angles. The physical-optics current is assumed as a trial function in the variational expression. A relatively simple general expression is obtained and specialized to the case of thin double cones, parabolic ogives, and semi-infinite circular cylinders capped with a cone or ogive. Numerical results are given. (See also Report 925-6 below.)

Note: This 925 report series deals with an investigation entitled "Countermeasures Against Radar Absorbing Materials." Several of the reports are classified and abstracts are in other volumes of this bibliography.

5704 Report 925-2 (RADC-TN-60-152), "An Experimental Study of Bistatic Scattering from Some Small, Absorber-Coated, Metal Shapes," R. J. Garbacz and D. L. Moffatt, AF 30(602)-2042, 23 May 60, (44:11), Unclassified, AD 240 852.

Experiments were conducted on the bistatic cross-sections of small metal bodies, both uncoated and coated with a resonant, lossy layer. Spheres, cylinders, and cones were studied, all of a size to be in the resonant region at the wavelengths of observation (approximately 3 cm). In all cases, the coated bodies were effectively camouflaged in the back hemisphere, but not in the forward hemisphere. In forward directions, the cross-sections of the coated bodies were as large as, or larger than, those of the uncoated bodies. The bistatic angle beyond which this enhancement occurs becomes smaller as frequency decreases. The measurements were made at bistatic angles of 0° to 160°, with same-sense polarization, either vertical or horizontal. Also included is a brief section to show the ineffectiveness of placing dielectric or ferromagnetic coatings on small bodies (Rayleigh scatterers) to reduce the total scattering cross-section, and a comparison of the theoretical total cross-section for a small sphere with the

5704 (Cont.)

value derived from experimental data. Related classified conclusions are given in Report 925-3; see Volume IX.

5705 Report 925-5, "The Bistatic Scattering from a Class of Lossy Dielectric Spheres with Surface Impedance Boundary Conditions," R. J. Garbacz, AF 30(602)-2042, 15 Jan 61, (51:5), Unclassified, AD 263 326.

Network concepts are used to explain the theory of modal surface impedances on spherically symmetric geometries. The results are specialized to the case of lossy dielectric spheres for which the modal surface impedances become especially simple. Partial results of a computer program to obtain the bistatic scattering from such a class of spheres are presented in graphical form.

5706 Report 925-6, "A Physical Optics Approximation of the Scattering for Axial Incidence from Rotationally Symmetric Targets," D. L. Moffatt, AF 30(602)-2042, 15 Feb 61, (91:26), Unclassified, AD 256 329.

Extension of Adachi's work (Report 925-1 above) resulted in a physical-optics approximation for monostatic and bistatic scattering from selected geometrical shapes. The axial backscatter from spheres, double cones, parabolic ogives, semi-infinite cones, and semi-infinite cylinders with conical caps is examined theoretically for several values of surface impedance. Bistatic E-plane cross-section is calculated for several of these geometries. Both metallic and lossy-dielectric surfaces are considered. Limitations of the solution are discussed in terms of the target geometry and material.

5707 Report 1021-1, "A Passive Communications System Utilizing a Photoconductive Modulation Technique," W. E. Bulman and R. W. Crawford, AF 33(616)-6782, 24 Feb 60, (19:6), Unclassified, AD 236 012.

Consideration of the possibility that a passive reflector could be used to modulate a CW signal emanating from a distant transmitter, and thereby transmit intelligence back to the transmitter site or to a third point. Chief attention is given to successful experiments aimed at showing that the return from a corner reflector can be modulated by making one or more faces of photo-conductive material and modulating the level of illumination applied to the face. Results are preliminary.

Note: The 1021 report series deals with an investigation entitled "Ion Sheath Research."

5708 Report 1021-5, "A Missile Borne S-Band Plasma Re-Entry Experiment," R. C. Taylor, R. K. Long, and R. J. Plugge, AF 33(616)-6782, 15 Jul 61, (-:3), Unclassified, AD 261 110.

(BD-1965) This report describes the instrumentation and results of an experiment to determine the reflection characteristics of a re-entry plasma at 3200 Mc. The equipment was flown on an Atlas missile equipped with a General Electric RVX-2A ablative nosecone. The flight was made in October, 1960.

5709 Report 1021-15, "A Reflectometer Experiment at S-Band for Re-Entry Vehicles," P. Bohley, AF 33(616)-6782, 15 May 62, (-:1), Unclassified, AD 276 498.

(BD-3050) Description of the design and construction of an S-band reflectometer for re-entry vehicle operation.

OHIO STATE UNIVERSITY RESEARCH FOUNDATION, ANTENNA LABORATORY (CONT.)

5710 Report 1073-1 (AFCRC-TN-60-795), "Echo Area of Combinations of Cones, Spheroids and Hemispheres as a Function of Bistatic Angle and Target Aspect," J. W. Eberle and R. W. St. Clair, AF 19(604)-6157, 30 Jun 60, (36:1), Unclassified, AD 242 479.

Included in this report are 300 bistatic scattering patterns of various combinations of cones, spheroids, and hemispheres. Each shape had a diameter of 4.27 cm, and heights ranged from 1.475 cm to about 10 cm. RCS patterns of each combination were taken with both horizontal and vertical polarization. The CW measurement system operated at a wavelength of 3.2 cm, and measurements were taken at bistatic angles of 0, 30, 60, 90, 120, and 140°. The equipment and the method used to calibrate the patterns are described, as well as a technique which permits the phase of a scattered signal to be determined with respect to a fixed reference signal.

Note: The 1073 report series deals with an investigation entitled "Monostatic and Bistatic Measurement of Scattering Shapes and Synthesis of Scattering Shapes."

5711 Report 1073-2 (AFCRC-TN-60-950), "The Theory and Application of the Scattering Matrix for Electromagnetic Waves," R. Tsu, AF 19(604)-6157, 1 Aug 60, (83:14), Unclassified, AD 243 689.

A general scattering relationship is derived and its familiar form for plane-wave incidence (cross-section theorem) is obtained. The determination of the scattering matrix from scattering measurements is then discussed, and one method is demonstrated with several examples. The scattering matrix is applied to the study of optimum scatterers, where an optimum scatterer is defined as one giving maximum or minimum scattering into a cone of specified orientation. Optimization of the scattering patterns for spherically symmetric bodies is demonstrated as an example. These results may be used in synthesizing the scattering pattern for spherically symmetric scatterers.

5712 Report 1073-3 (AFCRC-TN-60-376), "The Evaluation of Incomplete Normalization Integrals and Derivatives with Respect to the Order of Associated Legendre Polynomials," R. Tsu, AF 19(604)-6157, 1 Apr 60, (20:5), Unclassified, AD 238 953.

This report deals with mathematical problems arising from the study of optimum scatterers (see preceding abstract). The incomplete normalization integrals and their derivatives with respect to the order of the associated Legendre polynomials are evaluated. Results are given in short tables and curves.

5713 Report 1073-4 (Final Engineering Report; AFCRL-193), "Problems in Electromagnetic Scattering Analysis," AF 19(604)-6157, 1 Jan 61, (44:15), Unclassified, AD 255 839.

This is the final report in a series of four on a research program with two purposes: to develop equipment capable of recording phase and amplitude data on bistatic scattered signals as a function of aspect, and to study, both theoretically and experimentally, methods of synthesizing targets which will exhibit prescribed scattering properties. Only briefly discussed are those portions of the program treated in the reports abstracted above. Additional work not included in the preceding reports is also presented. This includes an investigation of the scattering of transient electromagnetic waves by finite bodies. This problem was approached two ways: (1) For fixed directions of source and observer relative to the

OHIO STATE UNIVERSITY RESEARCH FOUNDATION, ANTENNA LABORATORY (CONT.)

5713 (Cont.)

scatterer, scattering properties of the bodies were investigated as a function of source frequency, either by varying it or by assuming the incident wave to be an arbitrary, transient, plane wave. (2) For a fixed source frequency, the angular distribution of the scattered signal was correlated with scatterer shape, size, and composition. Discussions are only included for the first approach and its application to perfectly conducting and dielectric spheres. It was concluded that the far-field scattered waveform for short-pulse excitation of scatterers is relatively simple in form and can be related to the geometry and construction of the scatterer.

5714 Report 1108-6 (Final Report; AFCRL-751), "Experimental Program to Determine Properties of Ionization Which Is Produced by Space Vehicles," AF 19(604)-7274, 30 Jun 61, (18:25), Unclassified, AD 264 035.

Summary of a program to determine the density, duration, and extent of ionization produced in the ionosphere by artificial satellites and space vehicles. Theoretical analysis of single-frequency satellite radio transmissions has provided basic equations and methods for gaining information concerning the electron density at the satellite. Phenomena such as magnetic disturbances, ionospheric irregularities, and satellite signal scintillation are analyzed, and other studies, such as expected high-frequency reflection from suggested distributions around the satellite, are evaluated. There appears to be a possibility that satellite-ionosphere interactions, especially during periods of high geomagnetic activity, will create a disturbance having a large radar cross-section. The primary frequency of interest was 10 Mc.

5715 Report 1109-3, "The Effect of Antenna Installations Upon the Echo Area of an Object," R. B. Green, AF 33(616)-7386, 29 Sep 61, (30:13), Unclassified, AD 274 041.

Antennas mounted on a complex target can greatly influence its scattering pattern. This report develops a general theory of antenna effects at fixed aspect and frequency, and extends the analysis to the average echo area over aspect ranges. An equation is developed for the scattered fields of an antenna in terms of its transmitting parameters and its scattering properties when short-circuited. With this formula, there can be obtained such quantities as backscatter and total scatter as a function of load.

5716 "Quarterly Status Report," AF 19(604)-7270, Unclassified.

Report	Date
1116-1	1 Sep 60
1116-2	1 Dec 60
1116-5	1 Mar 61
1116-37	1 Sep 63

Note: These quarterly reports were not obtained. The program describes an investigation entitled "A Theoretical Study of The Modification in Echo Area of Space Vehicles Due to Their Local Space Environment."

5717 Report1116-3 (Scientific Report 1; AFCRL-89), "Echo Area from Satellite Wakes Acting as Dielectric Rod Antennas," L. Peters, Jr., AF 19(604)-7270, 31 Jan 61, (20:17), Unclassified, AD 254 857.

OHIO STATE UNIVERSITY RESEARCH FOUNDATION, ANTENNA LABORATORY (CONT.)

5717 (Cont.)

The large echo areas presented by the wakes of satellites in the ionosphere, are explained as being due to an evacuated wake at the rear of the satellite. The echo area of such a wake is calculated by treating it as a dielectric rod antenna. Conclusions presented are based on the model of particle distribution about the satellite which was developed by Dolph and Wiel (see University of Michigan "Studies in Radar Cross-Section XXXVII," Secret). Several conditions are outlined which must be satisfied in order that the proper mode be supported. Among these are: (1) Radar frequency f is related to the plasma frequency f_p of the ionosphere such that $f_p < f < 1.8\ f_p$ is satisfied. (2) The diameter of the evacuated wake (in meters) is at least $150/f_p$, where f_p is in Mc. (3) Radar transmitter and receiver positions are such that the satellite is traveling either toward both or away from both. When these severe conditions are met, large echo areas which have been observed with signal bursts from Station WWV can be explained. The fact that the conditions are severe and will frequently not prevail may explain why reflections of WWV bursts from the satellite do not appear regularly.

5718 Report 1116-4 (Scientific Report 2; AFCRL-310), "Coherent Scattering of a Metallic Body in the Presence of an Ionized Shell," L. Peters, Jr. and W. G. Swarner, AF 19(604)-7270, 7 Mar 61, (21:16), Unclassified, AD 256 359.

The metal sphere with a concentric dielectric shell is assumed as a model of a satellite in the presence of an ionized sheath, and its cross-section determined numerically with the aid of approximation techniques. For sphere radii small compared to λ, and dielectric constants less than that of the ambient atmosphere, a deep null in cross-section is observed. Cross-section is greatest when the relative dielectric constant of the shell is greater than two. The cross-section is approximated as the vector sum of scattering from the air-dielectric interface and that due to focussing on the metal sphere. Among the results obtained is that the configuration is nearly invisible for some cases. For example, the echo area of a metal sphere 0.05λ in radius is decreased about 50 dB by the presence of a sheath of relative dielectric constant 0.75 and thickness 0.035λ. Also discussed was scattering from the evacuated wake behind a satellite, which is presumed to act as a dielectric-rod antenna.

5719 Report 1116-6 (Scientific Report 3; AFCRL-382), "Endfire Echo Area of Plasma Cylinder Configurations," L. Peters, Jr., AF 19(604)-7270, 15 May 61, (19:14), Unclassified, AD 260 344.

Discussion of techniques for determining the endfire echo area of various plasma cylinder configurations. The target is considered to be a thin linear antenna that is excited by either the lowest-order transverse magnetic mode or the lowest-order hybrid mode; these methods could be used to determine the echo area of the highly ionized wake of a re-entry body.

5720 Report 1116-7 (Scientific Report 4; AFCRL-715), "Memorandum on the Average Radar Echo Area of Orbiting Satellites," B. Potts, AF 19(604)-7270, 23 Jun 61, (5:9), Unclassified, AD 264 033.

Average cross-sections are listed for all orbiting United States satellites (as of 31 March 1961) at the frequencies of 10, 20, and 30 Mc. Four different procedures were used to calculating the cross-sections, depending upon the size and configuration. Approximate average RCS ranged from 10^{-8} to 10^{3} m^2.

5721 Report 1116-8 (AFCRL-749), "Annual Summary Report," AF 19(604)-7270, 1 Jun 61, (16:20), Unclassified, AD 264 034.

A brief summary of material given in detail in the preceding reports of the series.

5722 Report 1116-13, "Quarterly Status Report," AF 19(604)-7270, 1 Sep 61, (23:4), Unclassified, AD 295 192.

Brief discussions summarizing various aspects of the program; details are covered in other reports.

5723 Report 1116-14 (Scientific Report 9; AFCRL-62-7), "Approximation for Backscatter from a Dielectric Sphere," D. T. Thomas, AF 19(604)-7270, 15 Oct 61, (13:8), Unclassified, AD 270 743.

An approximation method based on ray optics is described for predicting the cross-section of dielectric spheres. The backscatter cross-section is considered to comprise a front-face reflection obtained by multiplying the geometrical-optics cross-section by the power reflection coefficient, plus a twice-refracted rear-face reflection coefficient. Total cross-section was computed for dielectric constants of 0.25, 0.50, 0.75, 1.25, 1.50, and 2.0 as a function of sphere radius-to-wavelength ratio. These were compared with values computed by exact techniques and by Rayleigh-region approximations. Agreement of exact and approximate solutions demonstrates the validity of the approximations, showing that reasonable estimates of cross-section can be obtained for dielectric spheres without the usual lengthy computations.

5724 Report 1116-15, "Quarterly Status Report," AF 19(604)-7270, 1 Dec 61, (31:21), Unclassified, AD 295 196.

Brief summaries of various aspects of the program; details are given in other reports.

5725 Report 1116-17 (Scientific Report 10; AFCRL-62-144), "A Proposed Scattering Range for Simulated Echo Area Measurements of Plasma-Coated Objects," T. A. Brackey, L. Peters, Jr., W. G. Swarner, and D. T. Thomas, AF 19(604)-7270, 27 Jan 62, (14:13), Unclassified, AD 274 075.

This report describes an investigation of a proposed scattering range, to be used for experimentally simulating echo-area measurements of dielectric and dielectric-coated bodies having dielectric constants less than one. The proposed approach involved using a tank filled with a liquid having a high dielectric constant to serve as the ambient medium. A body coated with a dielectric having a dielectric constant less than that of the liquid would then simulate a body having a coating of dielectric constant less than unity in vacuo, and RCS measurements could be made. The investigation revealed that a mixture of transil oil, TiO_2, and petrolatum satisfied the requirements for the ambient liquid. It was concluded that the system was feasible but would involve numerous problems; the system was therefore not recommended for construction.

5726 Report 1116-18, "Quarterly Status Report," AF 19(604)-7270, 1 Mar 62, (24:10), Unclassified, AD 295 198.

Brief summaries of various aspects of the program; details are given in other reports.

OHIO STATE UNIVERSITY RESEARCH FOUNDATION, ANTENNA LABORATORY (CONT.)

5727 Report 1116-19 (Scientific Report 12; AFCRL-62-183), "Further Studies of the Radar Cross Section of Plasma Clad Bodies," L. Peters, W. G. Swarner, and D. T. Thomas, AF 19(604)-7270, 15 Mar 62, (25:8), Unclassified, AD 274 795.

Approximate methods based on the pertinent scattering mechanisms are given for determining the radar cross-sections of plasma-clad bodies. A superposition principle is used combining the scattered fields from the sheath alone and from a representation of the metal body, modified to take account of refraction and other effects. Approximate cross-sections of spherical bodies clad in concentric spherical sheaths are compared with the exact multipole expansion solutions; excellent agreement is found for all sizes and dielectric constants except for small restricted regions. A particular case treated is the non-concentric dielectric-coated sphere.

An approximate method based on macroscopic properties is given for determining the cross-section of dielectric bodies. This method is superior to previous methods in accuracy, simplicity, and range of validity, thereby removing a serious restriction of the superposition method--the need for exact solutions for dielectric bodies which do not exist for most shapes. The report is liberally illustrated with graphs of exact and approximate cross-sections for the different configurations as functions of the pertinent geometric parameter normalized with respect to λ, and for various dielectric constants.

5728 Report 1116-20 (Scientific Report 13; AFCRL-62-735), "Scattering by Plasma and Dielectric Bodies," D. T. Thomas, AF 19(604)-7270, 1 Aug 62, (97:39), Unclassified, AD 286 854.

Describes a modified geometrical-optics approximation for predicting resonant-region scattering by plasma and dielectric bodies. The plasma bodies are assumed to be dielectric bodies having relative permittivity less than unity. Ray-tracing techniques are employed to find the emergent rays contributing to the scattering. The amplitude and phase of the fields associated with each ray are calculated using classical geometrical optics when possible; when necessary, modifications using physical optics are applied. Finally the component fields obtained for each emergent ray are added to give the total field. The method is applied to the infinite circular cylinder, the sphere, a thin spherical shell, and a prolate spheroid. For the first three of these, the results are compared with exact values obtained by the boundary-value solution; these comparisons are illustrated graphically. For the prolate spheroid, experimental results were obtained using models. The results were good for bodies of near-resonant size having dimensions ranging from 0.8λ to 4.0λ. The generality of the method and good results indicate that it may be of value in calculating scattering from dielectric bodies of arbitrary shape.

5729 Report 1116-21 (AFCRL-62-764), "Radar Cross Sections of Dielectric or Plasma Coated Conducting Bodies," W. G. Swarner, AF 19(604)-7270, 15 Aug 62, (99:24), Unclassified, AD 286 855.

Radar cross-sections were obtained for a variety of spherical and cylindrical scatterers having dielectric or plasma shells by using the exact boundary-value solutions as well as approximate methods based on physical principles. The plasma was assumed to have the microscopic properties of a lossless dielectric with a relative permittivity less than that of free space. Exact solutions are presented for the bistatic cross-section of homogeneous dielectric spheres, conducting spheres, and concentric dielectric-coated conducting spheres in both the E-plane

OHIO STATE UNIVERSITY RESEARCH FOUNDATION, ANTENNA LABORATORY (CONT.)

5729 (Cont.)

and the H-plane; also for two concentric infinite circular cylinders of arbitrary composition under normal illumination by a plane wave polarized either parallel or perpendicular to the cylinder axis. Superposition was used, as in Report 1116-19 (above). The cross-section of a conducting sphere with non-concentric spherical dielectric shell was calculated by means of this superposition approximation, and found in excellent agreement with experimental measurements.

5730 Report 1116-23 (AFCRL-62-765), "Annual Summary Report 2," AF 19(604)-7270, 1 Sep 62, (51:20), Unclassified, AD 286 856.

A year's work on electromagnetic scattering by bodies in the ionosphere is reviewed with enough detail as to constitute a useful reference. Much of the material is concerned with scattering from plasma-clad bodies of various shapes, and a number of different studies in this field are briefly described. Also considered is scattering by plasma and dielectric bodies. Several pages deal with studies on the ionosphere and the general satellite environment. Noteworthy among these studies is an investigation into the interaction of satellites with the ionosphere, and the possibility of detecting satellites by this phenomenon.

Graphs summarize results on backscatter and bistatic scatter from concentric plasma- or dielectric-coated spheres; backscatter from concentric plasma- or dielectric-coated cylinders; backscatter from a conducting sphere with a non-concentric, spherical dielectric shell; backscatter from plasma and dielectric spheres and cylinders; backscatter from thin spherical shells; and the nose-on backscatter from a prolate spheroid.

5731 Report 1116-33 (Scientific Report 18; AFCRL-63-387), "Calculation of the Echo Areas of an n-Layer Plasma Cylinder and Sphere," T. Kawano and L. Peters, Jr., AF 19(604)-7270, May 63, (20:4), Unclassified, AD 423 019.

Cross-sections of inhomogeneous plasma bodies were studied with the modified geometrical-optics method. Formulas for the cross-section of an n-layer plasma cylinder were deduced from those for the cross-sections of the homogeneous, two-layer, and three-layer cylinders. Equations for the scattered fields due to the specular rays from the i^{th} layer of an n-layer body are given. The total field scattered by this multilayered body is simply the phasor sum of the components above.

5732 Report 1116-34 (Scientific Report 22; AFCRL-64-45), "Oblique Incidence on Plane Boundary Between Two General Gyrotropic Plasma Media," H. Unz, AF 19(604)-7270, 15 Oct 63, (33:15), Unclassified, AD 437 939.

Solution to the problem of an electromagnetic wave incident obliquely on a plane boundary between two different homogeneous gyrotropic plasma media. Two characteristic transmitted waves and two characteristic reflected waves will result; corresponding reflection and transmission coefficients are evaluated. Appendices treat three special cases: (1) the wave is incident on a plasma from free space; (2) the wave is incident within the medium upon the boundary of free space; and (3) the wave is incident from plasma upon a perfect conductor.

5733 Report 1116-35 (Scientific Report 20; AFCRL-63-942), "Radar Cross-Section of Lossy Plasma Bodies in the Vicinity of Plasma Resonance," L. Peters, Jr., AF 19(604)-7270, 31 Aug 63, (9:5), Unclassified, AD 431 742.

OHIO STATE UNIVERSITY RESEARCH FOUNDATION, ANTENNA LABORATORY (CONT.)

5733 (Cont.)

It is suggested that the radar cross-section of a lossy plasma body at frequencies near plasma resonance may be approximated simply by multiplying the radar cross-section of a perfectly conducting body of the same size and shape by the square of the Fresnel reflection coefficient. This approximation is applied to several infinite cylinders and shown to be valid.

5734 Report 1116-36 (Scientific Report 21; AFCRL-63-943), "Oblique Incidence on General Magneto-Plasma Slab," H. Unz, AF 19(604)-7270, 15 Oct 63, (18:22), Unclassified, AD 431 888.

An arbitrarily polarized plane electromagnetic wave is obliquely incident from free space on a general homogeneous magneto-plasma slab. The electromagnetic fields inside and outside the slab are evaluated in terms of determinants, and reflection and transmission coefficients found.

5735 Report 1116-38 (Scientific Report 25; AFCRL-64-714), "An Extension of the Modified Geometrical Optics Methods for Radar Cross Sections of Dielectric Bodies," T. Kawano and L. Peters, Jr., AF 19(604)-7270, 15 Jan 64, (42:9), Unclassified, AD 606 092.

The modified geometrical-optics method was further modified in order to account for the internally reflected axial ray in regions where the geometrical-optics approach fails. Application is made to a dielectric sphere having $\epsilon = 2.592$; numerical calculations compared very well with those obtained by the exact boundary-value solution. Since the approach accounted for all expected scattering mechanisms for dielectric bodies, it was suggested that the technique could be used to obtain scattering cross-sections for dielectric bodies of general shape.

5736 Report 1116-39 (Scientific Report 24; AFCRL-64-296), "An Application of Modified Geometrical Optics Method for Bistatic Radar Cross Sections of Dielectric Bodies," T. Kawano and L. Peters, Jr., AF 19(604)-7270, 15 Nov 63, (45:5), Unclassified, AD 439 378.

The modified geometrical-optics method was used to calculate the bistatic radar cross-section of several plasma spheres having relative dielectric constants of 0.75. That particular value was chosen to demonstrate the case when corrections are required to the method. The calculated values compared very favorably with values obtained by boundary-value solution; however it was emphasized that the boundary-value solution cannot be obtained for all shapes, while the modified geometrical-optics method is not restricted by body shape. Several extensions of the method were also given, among them the concept of a new term to account for the shadowing phenomena. Also included was the concept of a small aperture with a quadratic phase distribution, which could be used in lieu of geometrical optics to account for the transmitted ray in small bodies having relative dielectric constants close to unity.

5737 Report 1116-41 (Scientific Report 23; AFCRL-64-46), "Comparison of the Superposition Approximation and the Modified Geometrical Optics Method for Radar Cross Sections of Dielectric-Clad Bodies," T. Kawano, L. Peters, and W. G. Swarner, AF 19(604)-7270, 15 Nov 63, (13:5), Unclassified, AD 437 585.

Two approximate methods for obtaining the radar cross-sections of dielectric- or plasma-coated bodies were compared. For the superposition-approximation method, the fields scattered by the inner body and by the outer shell are computed

5737 (Cont.)

separately and then combined as phasors to yield an approximate total scattered field for the coated body. Scattered fields of the shell are considered to be those of a homogeneous body having the same exterior size, shape, and dielectric constant; while those of the inner body are considered to be those of an equivalent body having a modified radius to account for the lens action of the shell. The basis of the modified geometrical-optics method is ray-tracing. Pertinent scattered rays must be determined; then the scattered fields are found, by applying either geometrical-optics or physical-optics using the principle of stationary phase.

Several examples for the two methods were compared. It was concluded that, for simplicity and accuracy, superposition approximation is best suited for predicting radar cross-sections of dielectric-clad conducting bodies in the resonance or Rayleigh regions; whereas the modified geometrical-optics method yields best results for cases where the inner body is large and accuracy is required.

5738 Report 1116-42 (Scientific Report 26; AFCRL-64-715), "A Computer Program for Radar Cross Sections of Dielectric Bodies Using the Modified Geometrical Optics Method," L-J Du, AF 19(604)-7270, 15 Jan 64, (41:3), Unclassified, AD 606 093.

This IBM 7094 computer program was written for the modified geometrical-optics method of evaluating electromagnetic backscattering from a cylinder made of plasma or dielectric material. The physical principles of the method and the results of a sample problem are discussed. An appendix contains flow diagrams and the program in Sactran programming language.

5739 Report 1116-43, "Third Annual Summary Report," AF 19(604)-7270, 1 Sep 63, Unclassified.

Note: This report was not obtained.

5740 Report 1116-45 (Scientific Report 27; AFCRL-64-716), "Geometrical Optics for Gyrotropic Bodies," W. C. Y. Lee, L. Peters, Jr., and C. H. Walter, AF 19(604)-7270, 15 Apr 64, (35:10), Unclassified, AD 606 094.

The methods of geometrical optics are extended so that they may be applied to a gyrotropic body, specifically a magnetoplasma. Various internal and external reflections are considered at non-parallel planar interfaces, and means of determining ray paths or directions of energy flow are derived.

5741 Report 1116-47 (Scientific Report 30; AFCRL-64-901), "Modified Geometrical Optics for Electromagnetic Scattering by Gyrotropic Bodies," W. C. Y. Lee, L. Peters, Jr., and C. H. Walter, AF 19(604)-7270, 15 Aug 64, (46:9), Unclassified, AD 453 431.

The modified geometrical-optics method was applied to various gyrotropic bodies, including the infinite wedge, the infinite triangular cylinder, and the infinite circular cylinder. The solution was carried out completely for the wedge and the triangular cylinder. The solution for the circular cylinder was completed to the extent of locating the significant glory ray.

OHIO STATE UNIVERSITY RESEARCH FOUNDATION, ANTENNA LABORATORY (CONT.)

5742 Report 1116-48 (Scientific Report 28), "Electromagnetic Scattering by Gyrotropic Cylinders with Axial Magnetic Fields," W. C. Y. Lee, L. Peters, Jr., and C. H. Walter, AF 19(604)-7270, 15 May 64, (36:13), Unclassified, AD 606 095.

The modified geometrical-optics method was applied to a gyrotropic cylinder with an axial magnetic field, and the solution compared with the exact boundary-value solution; the favorable results obtained are illustrated graphically. An advantage of the method is that it may be applied to a general cylindrical cross-section without further development; however, for other orientations of the magnetic field, the calculations would be very tedious.

5743 Report 1116-51 (Final Report; AFCRL-64-991), "A Theoretical Study of the Modification in Echo Area of Space Vehicles Due to Their Local Space Environment," AF 19(604)-7270, 1 Dec 64, (76:32), Unclassified, AD 457 506.

This is a useful and well-illustrated summary of research results from a four-year study of scattering by bodies in the ionosphere. Optical techniques involving superposition and modified geometrical-optics methods are summarized and compared for their application to dielectric or plasma-clad bodies, as well as to bistatic and monostatic scattering by anisotropic bodies. Various experimental and theoretical studies on ionospheric electron densities, magneto-ionic theory, and other ionospheric phenomena are also reviewed.

5744 Report 1179-1, "Back-Scattering of Circularly Polarized Waves from Slightly Rough Surfaces," J. L. George, N-2811 with Jet Propulsion Laboratory, 30 Apr 61, (11:5), Unclassified, AD 407 424.

Interaction of circularly polarized electromagnetic radiation with a slightly rough surface is examined in hopes of predicting the radar backscatter coefficient of the moon. Results are compared with measurements of Pettengill (Abstract 8166J) and with a postulated complex permittivity. Since agreement between theory and data is not good, suggestions are made for experiments which would confirm or refute the slightly-rough-surface model of the moon from which the theoretical cross-section was derived.

Note: The 1179 report series deals with an investigation entitled "Surface Electromagnetic Reflection Characteristics."

5745 Report 1179-2, "Dielectric and Loss Effect of Particle Size," J. F. Reid, N-2811 with Jet Propulsion Laboratory, 22 Jun 61, (9:4), Unclassified, AD 407 026.

The electromagnetic properties of various aggregates of sand-like or dust-like particles were studied experimentally, pursuant to the general problem of determining the reflective properties of the lunar surface. Phase shift and attenuation were measured at X-band as a function of depth. Calculated dielectric and loss tangent are plotted as functions of particle size for various materials.

5746 Report 1179-4 (Final Engineering Report), "Surface Electromagnetic Reflection Characteristics," N-2811 with Jet Propulsion Laboratory, 1 Nov 61, (26:12), Unclassified, AD 295 195.

Theoretical and experimental studies were pursued in order to better understand the lunar surface as revealed through its scattering properties. Evidence is presented which substantiates the need for a high-altitude-rocket radar to gather additional scattering data in the microwave region. Results of a study on

5746 (Cont.)

the dielectric constant of aluminum oxide are given for particle size varying from near zero to over 300 mesh. Graphs are given for backscattering from layers of smoothed sand and 0.8-cm gravel. Experiments were performed at X-band, K_u-band, and K_a-band. Further experiments are suggested which should lead to more definite conclusions regarding the surface of the moon.

5747 Report 1223-3 (Interim Engineering Report), "Electromagnetic Scattering by Radially Inhomogeneous Spheres," R. J. Garbacz, AF 33(616)-8039, 9 Jan 62, (40:17), Unclassified, AD 275 370.

A method is developed for computing the scattering cross-sections of spheres that are radially inhomogeneous in μ and/or ϵ. The scattering coefficients are expressed in terms of functions satisfying certain Riccati equations which can be solved by high-speed computer techniques. By substituting desired permittivity and permeability distributions into these equations and choosing proper end conditions, the associated modal surface impedances and admittances at the sphere surface can be obtained by numerical integration. From these, corresponding values of the scattering coefficients are obtained from which scattered fields may be calculated. Bistatic scattering was calculated for two inhomogeneous spheres, for the Luneburg lens, and for the Eaton-Lippmann lens. No experimental data were taken to varify the theoretical scattering patterns, but the solution for the Luneburg lens was in excellent agreement with results obtained by Lincoln Laboratory using the more orthodox multiple-layer approximation. It was concluded that this technique is well suited to cases where there is only a radial inhomogeneity.

Note: The 1223 report series deals with an investigation entitled "Research on Radar Camouflage and Antenna Echoes." Many of the reports are classified and abstracts are in other volumes of this bibliography.

5748 Report 1223-5, "Low Radar Cross Sections, the Cone-Sphere," D. L. Moffatt, AF 33(616)-8039, 15 May 62, (42:12), Unclassified, AD 283 338.

A method is presented whereby the axial echo area of a cone-sphere may be derived by approximating the response of the cone-sphere to an impulsive electromagnetic wave. The impulse analysis was also used to investigate the effectiveness of certain suggested modifications to the cone-sphere shape. Calculated results were compared with measured data and found to be in substantial agreement. Some additional conclusions from the work were: (1) Within reasonable limits, cone-angle has negligible effect on the magnitude of the axial echo area of the cone-sphere. (2) Axial echo area comes predominantly from the wave diffracted by the discontinuity in the derivative of the slope at the cone-sphere junction and from the creeping wave around the back of the sphere. (3) Except for very long targets, it is not feasible to reduce axial echo area by eliminating the discontinuity described in (2) through such means as including a transition section or replacing the cone with an alternate shape. (4) The axial echo area may be substantially reduced by using an absorber-coated sphere to reduce the creeping wave and eliminate the effects of the slope-derivative discontinuity.

5749 Report 1223-7, "A Memorandum on a Measurement Technique for Low Cross Sections," R. J. Garbacz, AF 33(616)-8039, 1 May 62, (9:4), Unclassified, AD 276 102.

OHIO STATE UNIVERSITY RESEARCH FOUNDATION, ANTENNA LABORATORY (CONT.)

5749 (Cont.)

A brief description of a technique for measuring low cross-sections, based on the principle of interference between scattered and background signals. In this technique, the target is made to move along the line of sight of a CW radar, so that the scattered signal from the target will interfere constructively and destructively with constant background and leak-through components, thereby causing linear variations in the output that are directly proportional to the target return. By comparing these variations with those due to several different standard spheres, an absolute cross-section and error estimate can be obtained for the test target. Data obtained at 8.5 Gc on spheres indicate that scattered signals of the order .01 λ^2 can be measured to an accuracy of $\pm$ 5%.

5750 "The Determination of Antenna Parameters by Scattering Cross-Section Measurements," R. J. Garbacz, AF 33(616)-8039, Unclassified.

Report	Title	Date	Pages:Refs.	AD No.
1223-8	I. Antenna Impedance	30 Sep 62	34:18	286 760
1223-9	II. Antenna Gain	30 Nov 62	24:5	297 953
1223-10	III. Antenna Scattering Cross-Section	30 Nov 62	9:2	295 031

In Part I, an experimental procedure is described whereby the input impedance of an antenna may be determined from three or more measurements of scattering amplitude. The procedure consists of loading the antenna terminals with a calibrated reactive load whose variation changes the cross-section of the antenna, plotting load values associated with certain cross-sections on the Smith chart, and using geometrical constructions to yield input impedance directly. In order to verify the method, a few preliminary measurements were made on a 14-inch parabolic antenna and a horn antenna at a frequency of 9.0 Gc. The results are in fairly good agreement with results obtained by slotted-line methods on two Smith-chart presentations. Two appendices discuss the analytical development of this procedure.

The analysis of Part II enables evaluation of the power gain of an antenna in terms of its scattering cross-section. As in the measurement of impedance, no nulling of the system is required before the test antenna is placed in the field; however, calibration in terms of a standard echo is necessary. Experimental monostatic scattering measurements were made at 9.0 Gc for three antennas and the gains above an isotropic source for these antennas were determined. It was concluded that the results check closely enough to substantiate the validity of the scattering method for determining antenna gain.

Part III of this report assumes the input impedance Z_a and gain of an antenna have been determined from measurements of its scattering cross-section as discussed in Parts I and II, and develops a method for predicting an antenna's cross-section for any load Z_ℓ at its terminals. The procedure is the same as was used in obtaining input impedance except that the measurement system must be nulled before the test antenna is placed into the field. From determined values of Z_ℓ^{max}, Z_ℓ^{min}, σ_{max}, σ_{min}, Z_a and antenna gain, it is shown through the use of vector diagrams on the Smith chart that the cross-section of an antenna may be predicted for any load. As an indication to the validity of the procedure, experimental and

5750 (Cont.)

predicted curves of echo area vs. load are shown for a horn antenna with the system nulled; agreement is quite good.

5751 Report 1223-12, "Determination of Antenna Scattering Properties from Model Measurements," D. L. Moffatt, AF 33(616)-8039, 1 Jan 64, (38:8), Unclassified, AD 441 216.

Measurement procedures are discussed which are applicable to either model or prototype systems, and which yield a complete description of the scattering properties of an antenna. For facilities capable of measuring amplitude and phase, the procedure yields the scattered field and echo for any antenna load at any measured aspect, providing amplitude and phase measurements of the antenna input impedance and scattered field are made for two reactive loads. If amplitude measurements alone are available, measurement of the antenna input impedance and the echoing area for three reactive loads and one known, arbitrary, lossy termination yields the echo area for any load at any measured aspect.

Also presented is a technique for transforming a meaningful quantity through an arbitrary, lossless, passive, bilateral two-port which requires only a single bench measurement rather than complete calibration. This technique allows the scattering properties of antennas to be evaluated from model measurements without modeling either the antenna load or all of the associated transmission line. Results are given for some experimental measurements of the scattering properties of two full-scale antennas (one X-band horn and one 14-inch X-band paraboloidal reflector) and one modeled configuration (a conducting sphere with a radial stub antenna).

Note: Portions of this report were presented by the author as a symposium paper, see Abstract 5900.

5752 Report 1223-16, "Fields in the Focal Region of a Parabolic Receiving Antenna," E. M. Kennaugh and R. H. Ott, AF 33(616)-8039, 31 Aug 63, Unclassified.

Note: This report was not obtained.

5753 Report 1223-17, "The General Theory of Antenna Scattering," R. B. Green, AF 33(616)-8039, 30 Nov 63, (146:49), Unclassified, AD 429 186.

A simple mathematical model is described which permits visualization of those parameters that must be determined in order to specify completely particular scattering property of an antenna as a function of load. A geometrical interpretation using the Smith chart is also described. The model may be used to determine a measurement program whereby required parameters may be obtained efficiently. Several examples of these parameters are presented which illustrate how a load may be chosen in various optimum senses. The model also allows one to determine under which circumstances the Thevenin circuit may be used to predict the power scattered as well as absorbed from an antenna. The scattering matrix is derived and applied to the optimization of scattering from matched antennas.

5754 Report 1388-1, "A Theoretical Model for Scattering from Rough Surfaces, with Applications to the Moon and Sea," R. H. Ott, NASA Grant NsG-213-61, 10 Nov 61, Unclassified.

Note: This report was not obtained; 1388-2 (AD 295 193) is identical in content to 898-15 which is abstracted above.

OHIO STATE UNIVERSITY RESEARCH FOUNDATION, ANTENNA LABORATORY (CONT.)

5755 Report 1388-3, "Reflection of Circularly Polarized Radar Waves from a Very Rough Surface," H. F. Mathis, NASA Grant NsG-213-61, 15 May 62, Unclassified.

Note: This report was not obtained.

5756 Report 1388-4, "Interpretation of the Lunar Scattering Diagram," W. H. Peake and R. H. Ott, NASA Grant NsG-213-61, [1963], Unclassified.

Note: This report was not obtained.

5757 Report 1388-5, "Semi-Annual Engineering Report," NASA Grant NsG-213-61, 1 Jul 62, Unclassified.

Note: This report was not obtained.

5758 Report 1388-6, "Fundamentals of Radar Photometry," W. H. Peake, NASA Grant NsG-213-61, [1963], Unclassified.

Note: This report was not obtained.

5759 Report 1388-7, "Annual Summary Report," NASA Grant NsG-213-61, 1 Nov 62, Unclassified.

Note: This report was not obtained.

5760 Report 1388-8, "The Solution of an Integral Equation for the Lunar Scattering Function," R. T. Compton, Jr., NASA Grant NsG-213-61, 1 Apr 63, Unclassified.

Note: This report was not obtained.

5761 Report 1388-9, "Radar Back-Scattering Measurements from Moon-Like Surfaces," W. H. Peake and R. C. Taylor, NASA Grant NsG-213-61, 1 May 63, Unclassified.

Note: This report was not obtained.

5762 Report 1388-10 (Semi-Annual Report; NASA-CR-50859), "Theoretical and Experimental Analysis of the Electromagnetic Scattering and Radiative Properties of Terrain with Emphasis on Lunar-like Surfaces," NASA Grant NsG-213-61, 1 Jun 63, (10:-), Unclassified.

(RC-449) Theoretical and experimental studies were conducted to provide fundamental data needed to interpret or to design planetary radar experiments. Backscattering from moon-like surfaces was measured. Theoretical studies included: an analysis of the specular part of the lunar scattering in terms of a physical-optics model, which predicted a non-Gaussian second-probability distribution and gave an estimate of the rms slope of the intermediate-scale features of the lunar surface; fundamental studies in radar photometry, including the solution of the Doppler mapping problem in closed form; and studies of the polarization transforming properties of rough surfaces with application to the interpretation of lunar radar experiments using linear polarization. Preliminary studies were made of a proposed CW lunar radar experiment to be performed with the "Saucer Field" receiving system.

OHIO STATE UNIVERSITY RESEARCH FOUNDATION, ANTENNA LABORATORY (CONT.)

5763 Report 1522-7, "Scattering by an Arbitrary Array of Parallel Wires," J. H. Richmond, N123(953)31663A, 30 Apr 64, (25:4), Unclassified, AD 443 833.

Equations are developed for the scattering pattern of an arbitrary array of parallel wires. The wires are assumed to be infinitely long, perfectly conducting, and very small in diameter in comparison with the wavelength. The incident wave is assumed to be TM with respect to the wire axis, and to have arbitrary incidence angle. Interaction effects among the individual wires is considered in the solution. Theoretical equations are developed under these conditions, and computer programs to implement them are included in an appendix. Numerical calculations were carried out for planar, circular, square, and I-beam arrays of parallel wires. Representative results presented include the current induced on the various wires and the distant scattering patterns. Comparisons with physical-optics solutions indicate that when a sufficiently great number of wires per array is used, the scattering pattern approaches that of a solid conducting cylinder having the same cross-section shape as the wire-grid array.

5764 Report 1566-3 (Interim Engineering Report), "Research on Techniques for Integration of Active Elements into Antennas and Antenna Structure," AF 33(657)-10386, 1 Mar 63, (16:-), Unclassified, AD 408 662.

The purpose of this research program was to study techniques for integrating active elements into antennas and antenna structure. Included are descriptions of a 40-watt, 420-Mc varactor frequency multiplier; a transistorized VHF dipole antennafier; calculated patterns of a four-element array of transistorized dipoles with electronic amplitude-taper control; and preliminary work on the echo-area control of slot antennas mounted in a cone.

5765 Report 1566-4, "An Ultra-High Frequency CW Reflection Measuring System," S. Mikuteit, AF 33(657)-10386, 30 Jun 63, (79:17), Unclassified, AD 416 415.

Description of the construction, calibration, and operation of a 422-Mc, CW reflection-measuring system used for automatically recording backscattered radiation patterns of unified systems. The system was designed for ultimate use as a tool to investigate the feasibility of using antennafier techniques (i.e., the introduction of active or nonlinear elements as part of the radiating structure) to control the echo area of body-antenna systems, "antennafier" being a term used to describe the combination of an antenna and an amplifier into a single unit. Minimum measurable cross-section of a target supported on a steel tower at a range of 48 ft is 1 square wavelength with an accuracy of 1 dB. Included are several patterns of cross-section vs. aspect for flat plates and for a hybrid T-bar slot antennafier. When these results were compared with calculated theoretical patterns, agreement was within $\pm$ 1 dB.

5766 Report 1566-5 (Interim Engineering Report), "Research on Techniques for Integration of Active Elements into Antennas and Antenna Structure," AF 33(657)-10386, 1 Jul 63, (13:4), Unclassified, AD 412 438.

The purpose of this research program was to study techniques for integrating active elements into antennas and antenna structures. Included are some calculated and measured patterns of a four-element array of transistorized dipoles with electronic amplitude-taper control.

OHIO STATE UNIVERSITY RESEARCH FOUNDATION, ANTENNA LABORATORY (CONT.)

5767 Report 1774-1, "The Axial Echo Area of a Perfectly Conducting Prolate Spheroid," E. M. Kennaugh and D. L. Moffatt, AF 33(615)-1318, 15 Jun 64, (21:7), Unclassified, AD 446 398.

The axial echo area of a perfectly conducting prolate spheroid is derived using an impulse approximation. As a result, the echo area vs. frequency is obtained over the resonance region. Calculated results for a spheroid with 2:1 axial ratio are compared with experimental data for spheroids with major axes ranging from 0.318 to 1.59 wavelengths.

5768 "Antenna Laboratory Publications," W. A. Greene, Editor, Feb 61, (88:-), Unclassified, AD 256 470.

A listing of publications of the Antenna Laboratory from 1947 to February 1961. Publications are grouped by contract or series number and arranged in chronological order. Pertinent information presented for each includes sponsoring agency, contract number, title, author, date, and AD number; publications are indexed by author and subject. Also included is a selected list of theses, dissertations, and papers presented or published by Antenna Laboratory personnel during the above period. (See also next two abstracts.)

5769 "Antenna Laboratory Publications. Vol. II.," Jan 63, (46:-), Unclassified, AD 412 990.

A previous listing of publications (see preceding abstract) is extended to cover the period February 1961 through January 1963. (See also next abstract.)

5770 "Antenna Laboratory Publications. Electromagnetic Scattering," Dec 63, (56:450), Unclassified, AD 440 869.

A listing of over 450 publications and oral papers on topics related to electromagnetic scattering and radar cross-section published or presented by the staff of the Antenna Laboratory from 1947 to December 1963. The compilation is presented in four parts: published papers, oral papers, theses and dissertations, and technical reports. A complete listing of all Antenna Laboratory publications during the period 1947 to January 1963 is available in two earlier documents (see two preceding abstracts).

OKLAHOMA AGRICULTURAL AND MECHANICAL COLLEGE

5771 Ph.D. Thesis, "A Study of K-Band Backscattering Coefficients of Symmetrical Targets," L. A. Yarbrough, 3 Aug 57, (119:36), Unclassified, AD 140 074.

Backscattering coefficients of aluminum, brass, and iron spheres were measured at K-band. The aim was apparently to demonstrate the effects of the conductivity of the metallic spheres on their ability to reflect electromagnetic energy. Measured values of backscattering power correlated very closely with theoretical values; correlation with theory related to the radar equation shows the error involved when the conductivity of the metal is eliminated from consideration. Total backscattering from a complex target may be determined by reducing it to basic geometric configurations and combining backscatter values for each.

Ed: It is difficult to determine what the author's prime interest was in performing the work described in this document, but apparently it was the question of target conductivity and its effect on return.

OREGON STATE UNIVERSITY

5772 Quarterly Technical Report 7, "Instrumentation and Techniques for Army Weather Observation," F. W. Decker, H. Kershaw, Jr., L. D. Mendenhall, and W. G. Jensby, DA 36-039 SC-78918, 31 Jan 61, (30:1), Unclassified, AD 260 571.

This report presents a summary of radarscope observations with a 3.2-cm AN/CPS-9 set at McCulloch Peak, Oregon. Echo types appearing in different zones during various synoptic conditions are tabulated according to a simplified classification system. The possibility was investigated of evaluating the precipitation rate at a certain location by relating the absence or presence of an echo there to the amount of intervening echo. It is shown that certain nominal precipitation rates are required to produce a target echo for various amounts of intervening echo. Results for 109 cases showed that precipitation was observed at this station if the rate of fall exceeded $A = B + 3$, but that the radar did not see the precipitation for rates less than $A = 1.44(B - 15)$ (A is the peak intensity in hundredths of inches per hour, and B is the amount of intervening echo in miles). A zone of uncertainty lies between these two lines. Results for various antenna tilt angles are also given.

5773 Final Technical Report, "Investigation of Instrumentation and Techniques for Army Weather Observation," F. W. Decker, H. Kershaw, Jr., and L. D. Mendenhall, DA 36-039 SC-78918, 30 Apr 61, (123:104), Unclassified, AD 269 672.

This report contains a summary of radar film records obtained from a 3.2-cm AN/CPS-9 radar operated at Marys Peak, Oregon, during 1959-60 and at McCulloch Peak Research Center, Oregon, during 1960-61. Brief consideration is given to the behavior of lines and bands of echoes, the relationship of sea return to meteorological and sea conditions, the relationship of radar echoes to topography, and the special characteristics of radar echoes which precede the actual onset of precipitation at the ground.

5774 M.S. Thesis, "A Study of Radar Echo Patterns Related to Mesoscale Network Observations and Topography," K. B. Knechtel, 14 May 64, (84:25), Unclassified, AD 441 022.

This investigation deals with the relationship of observed radar reflectivity to that computed from measurements at surface stations under the radar beam. Drop-size distributions at stations in the University's Mesometeorological Network, during the storm period of 27-30 March 1963, provided data for computation of the radar reflectivity at the surface. At the same time, films of a 3.2-cm AN/CPS-9 PPI-scope recorded radar reflectivity as the beam scanned above the network. A derivation of the theoretical relationship between the reflectivity Z in the radar beam and the receiver gain step G_r, which gives a relative measure of the average return power, yielded a final result in the form

$$\log Z\ (m^3/mm^6) = 0.1\ G_r\ (db^{-1}) + \text{constant},$$

where 0.1 represents the regression coefficient. Replacing the reflectivity Z in the beam by the computed reflectivity at the surface Z_s yielded a set of data pairs (Z_s, G_r) for each surface observing station. The method of least squares for each

OREGON STATE UNIVERSITY (CONT.)

5774 (Cont.)

set of data yielded sample regression curves of the form

$$\log Z_s\ (m^3/mm^6) = b(G_r)(db^{-1}) + \text{constant.}$$

At the 5% level of significance, the new relationship remained linear in 90% of the cases, and at the 10% level of significance, the regression coefficient remained equal to 0.1 in 90% of the cases.

PACIFIC NAVAL LABORATORY (CANADA)

5775 Report 61-1, "The Resultant Magnetic Field at the Surface of a Flat Conductor for an Incident Plane Wave," H. W. Dosso and J. E. Lokken, Feb 61, (19:3), Unclassified, AD 257 477.

A wave is incident on a half-plane having finite conductivity; the resultant field components are complex. The ratio of the vertical component to the horizontal component of the magnetic field is computed and plotted for varying frequency, angle of incidence, conductivity, permittivity, and ratio of the amplitudes of the magnetic-field components of the incident wave normal to and in the plane of incidence. Conditions of primary interest were conductivities typical of dry earth, wet earth, fresh water, and sea water, and frequencies from 10^{-3} to 10^6 cps. The work is aimed at considering the magnetic field at the earth's surface due to a distant source, and its dependence on various parameters.

PENNSYLVANIA RESEARCH ASSOCIATES, INC.

5776 Interim Report 2 (Technical Report NAVTRADEVCEN 1025-2), "Investigation of Digital Techniques for Radar Land Mass Simulation," N61339-1025, 23 Aug 63, (192:32), Unclassified, AD 424 625.

Detailed discussion of theory and specifications for reproducing the display of a scanning ground-mapping radar. Two basic methods--function approximation and contour interpretation--are discussed for representing natural terrain in digital form. A model is formulated for encoding and preparing map data to reconstruct terrain profiles in real-time synchronism with the airborne-radar display. In functional approximations, basic problems were the necessity of accuracy in lateral positioning, terrain partitioning, and dimensionality. The terrain descriptions investigated were: fitting techniques, the L-method, piecewise approximation with the Hill function and spatial impulse, the least-squares method, and contour interpolation. Straight-line contour approximations were made by line-generating algorithms. The report suggests that hybrid analog-digital hardware can handle reflectivity data and weather information. The final output is in an analog form suitable for display equipment.

Note: Interim Report 1 on this contract (NAVTRADEVCEN 1025-1, AD 276 696) was not obtained.

5777 Final Report (NAVTRADEVCEN 1025-3), "Investigation of Digital Techniques for Radar Land Mass Simulation," N61339-1025, 13 Mar 64, (317:55), Unclassified, AD 600 240.

The history of radar land-mass simulation and the two previous project reports are summarized. Design of a hybrid radar-simulator system is discussed

PENNSYLVANIA RESEARCH ASSOCIATES, INC. (CONT.)

5777 (Cont.)

in relation to the various goals, and each portion of the mass simulator is analyzed. The transformation of data from the simulated world to the radar considers: low-altitude effects, azimuth-dependent effects, receiver features, and equipment coupling. A mathematical model is formulated to describe these effects so that the terrain profile can be transformed into video waveforms. Different degrees of simulated realism are explored by mechanizing shadow and specularity models. Simulation techniques for cultural areas are discussed, and it is estimated that storage capacities and data rates will be lower for cultural areas than for terrain. Algorithms for reconstructing height and reflectivity profiles for cultural complexes are presented.

PENNSYLVANIA STATE UNIVERSITY, IONOSPHERE RESEARCH LABORATORY

5778 Scientific Report 104 (AFCRC-TN-58-452), "Coupling and Polarization Computations Approximated by a Single Discontinuity in the Medium," W. Becker, A. J. Ferraro, and J. J. Gibbons, AF 19(604)-1304, 1 Jul 58, (33:14), Unclassified, AD 152 628.

Development of theoretical expressions for the polarization of backscattered and forward-scattered components for signals vertically incident on the ionosphere. A step discontinuity in the ionosphere is assumed, and WKB solutions are used as the wave function. Coupling between ordinary and extraordinary modes is taken into account by solving a boundary-value problem at the discontinuity. The "main" echo polarization is computed at 150 kc.

5779 Scientific Report 110 (AFCRC-TN-58-637), "Vertical Incidence Equivalent Height Recordings at 75 kc/s," D. J. O'Brien and W. J. Ross, AF 19(604)-3875, 1 Sep 58, (91:6), Unclassified, AD 209 015.

The results of vertical-incidence pulse sounding of the ionosphere at 75 kc from October 1955 to February 1957 are tabulated. Median curves are drawn and discussed briefly; eighty pages of detailed data are included. The main classes of complex echoes are shown and discussed briefly, and compared with similar, previously taken records at 150 kc.

5780 Scientific Report 114 (AFCRC-TN-59-221), "Digital Computer Determination of Low Frequency Polarization," A. J. Ferraro, AF 19(604)-4563, 31 Dec 58, (38:10), Unclassified, AD 210 487.

Presented are the results of a method for determining the polarization of low-frequency echoes which include the effects of collisions and the terrestrial magnetic field. Echoes are assumed to result from vertical-incidence sounding of the ionosphere. A multislab model of the ionosphere was used, based on Rydbeck's coupled wave equation which describes the propagation of a radio wave incident vertically on a horizontally stratified ionosphere. Digital computer application to the multislab approximation is discussed. Computations for 150 kc for two models were made to obtain amplitude ratio and phase of extraordinary and ordinary backscattered waves.

5781 Scientific Report 178 (AFCRL-63-215), "Perturbation Methods Applied to the Reflection of Radio Waves from the Ionosphere," P. W. Norman, AF 19(604)-4563, 1 Feb 63, (28:10), Unclassified, AD 297 419.

A perturbation approach to the problem of determining the electromagnetic field reflected from the ionosphere is presented and its limitations discussed.

PENNSYLVANIA STATE UNIVERSITY, IONOSPHERE RESEARCH LABORATORY (CONT.)

5781 (Cont.)

It is shown that Maxwell's equation and the constitutive relationship are considerably simplified by treating the earth's field of magnetic induction as a perturbation. First-order approximations are found for the field reflected from a homogeneous sharply bounded ionosphere. This theoretical development assumes that the ionosphere is homogeneous and the magnetic field vertical, and takes the source to be a dipole located in free space below the interface.

5782 Scientific Report 183 (AFCRL-63-291), "Electromagnetic Nonlinear Interaction and Reflection from a Plane Ionized Medium," O. E. H. Rydbeck, AF 19(604)-4563, 15 Apr 63, (48:5), Unclassified, AD 200 981.

States the reflection properties of an isotropic ionized medium in the presence of non-linear effects produced by a separate very powerful pump wave ω_p. It is shown that when a primary signal ω_o impinges on the disturbed ionized medium at some specified angle, waves of frequencies ω_o, $\omega_o + \omega_p$, and $\omega_o - \omega_p$ are returned from the layer. The laws of reflection and refraction for these waves, which may be considered as typical expressions for the non-linear optics of the system, are deduced. The process is related to the principles of parametric amplification. Presented are theoretical descriptions of: (1) the wave equation in the oscillating medium, using Maxwell's equation and Rydbeck's coupling laws; (2) reflection when only electron density oscillation is considered; and (3) reflection when both electron density and electron velocity oscillations are taken into account. Also treated are the effects of collisional losses on the system resonances, and dynamic non-linear reflection from a pumped inhomogeneous medium.

5783 Final Report (AFCRL-63-924), A. J. Ferraro and J. S. Nisbet, AF 19(604)-8012, 31 Aug 63, (41:185), Unclassified, AD 429 187.

Brief qualitative summary of investigations into the structure and variation of the lower ionosphere. The normal ionosonde sweep-frequency technique is extended into the low-frequency range, and ionosphere parameters are investigated by means of a conductivity rocket probe. An extensive reference and bibliography section is included, but no thorough technical discussions and conclusions are given.

5784 Scientific Report 206 (AFCRL-64-32), "Investigation of Phase Interaction as a Means for the Study of the Lower Ionosphere," S. Weisbrod, AF 19(628)-3842, 1 Mar 64, (155:35), Unclassified, AD 435 736.

Presents a new technique for studying the lower ionosphere (60-90 km), using simultaneous observations of phase and amplitude wave interaction due to the Luxembourg effect. A 50-kw transmitter was used at 300 kc to irradiate the lower ionosphere, thereby changing the amplitude and phase of radio signals passing through the affected region. The disturbing pulses are staggered with the wanted transmissions so that they interact (occupy the same point in the ionosphere) at certain discrete points. The theory of wave interaction is expanded to include the complex coefficient of interaction which leads to phase-perturbation definition. Numerical estimates, based on this theory, showed that perturbations of phase comparable to those of amplitude exist and may lead to useful data. The perturbations were estimated at about 0.01% in amplitude and 10^{-4} radians in phase. Experimental results are given and are shown to be in very good qualitative

PENNSYLVANIA STATE UNIVERSITY, IONOSPHERE RESEARCH LABORATORY (CONT.)

5784 (Cont.)

agreement with theoretical computations. Approximately two-thirds of the report is devoted to detailed system, sub-system, and circuit descriptions of the instrumentation used.

5785 Scientific Report 214 (AFCRL-64-611), "Techniques for the Determination of Reflection Coefficient and Virtual Height of Low Frequency Radio Waves," C. P. Tou, AF 19(628)-4014 and NSF Grant GP-846, 20 Jul 64, (52:12), Unclassified, AD 447 109.

Reflection coefficients for different profiles of electron density are calculated by an accurate full-wave method for radio waves vertically incident on an ionospheric layer. Group heights of reflection are also calculated by a full-wave method and compared with those obtained using zero-collision-ray theory. The errors produced these two different ways are quite small for certain conditions. This implies that a zero-collision-ray method of calculating the true heights of reflection can be used for low-frequency ionogram reduction. Linear, parabolic, and cosine profiles were treated; frequencies from 100 to 1000 kc were used.

PHILCO CORPORATION (PHILADELPHIA, PA.)

5786 Technical Report NAVTRADEVCEN 790, "Investigation of Computer Techniques for Radar Land Mass Simulation," A. S. Corson, N61339-790, Nov 60, (91:-), Unclassified, AD 259 993.

(RC-11771) Digital simulation of radar land masses was studied. The work was intended to define the problem of digital simulation and to determine the feasibility and practicality of using available techniques and/or equipment. Methods of digitizing elevation and reflectivity data and the applicability of current components and techniques is investigated. Based on the technical approach followed in the study program, digital techniques are feasible but not yet practical for land mass simulation.

PICKARD AND BURNS, INC.

5787 Publication 735A (Scientific Report 1; RADC-TDR-61-285), "Bistatic Cross Sections of Cylindrical Wires," J. T. deBettencourt, AF 30(602)-2412 and AF 19(604)-8341, [1961], (53:6), Unclassified, AD 274 150.

Bistatic cross-sections of a thin, perfectly conducting cylinder are developed, using the variational method which Tai applied to monostatic cross-sections. Resulting expressions are developed for wires of length $3\lambda/2$ or less. The incident electric vector lies in the incident plane and the receiving antenna is polarized parallel to the scattering plane. Curves of monostatic and bistatic cross-sections are plotted. The curves for bistatic scattering show aspect and frequency sensitivity. Double humps or lobes are generally asymmetric in bistatic angle for given angle of incidence, particularly for wire lengths greater than 0.75λ. Thus forward-scattering gives larger cross-sections than backscattering under certain conditions.

PLESSET (E. H.) ASSOCIATES, INC.

5788 C25-60(U)40, TR-103 (Scientific Report 1; AFCRL-TN-60-1134), "The Use of Radar as an Ionospheric Probe," F. Richey and R. S. Wehner, AF 19(604)-6187, 11 Oct 60, (25:14), Unclassified, AD 247 764.

PLESSET (E. H.) ASSOCIATES, INC. (CONT.)

5788 (Cont.)

An analysis aimed at ascertaining the feasibility of using radar to measure electron density and collision frequency of the ionosphere as functions of space and time. It is shown that enhanced electron-density measurements can be made at 1000-km ranges by using a high-power (e.g., 10^7 watts), large-dish (85 ft) radar. For normal densities the range is reduced unless pulse integration or data processing is used. Also discussed is the possibility of using signal cross-modulation measurements to determine electron-molecule collision frequency. It is concluded that the technique is not feasible at microwave frequencies but that it may be at frequencies of 1 to 10 Mc.

5789 C25-61(U)60, TR-107 (Scientific Report 4; AFCRL-70), "High Resolution Ground-Based Simultaneous Measurement of Ionospheric Electron Density and Collision Frequency," F. Richey and R. S. Wehner, AF 19(604)-6187, 31 Jan 61, (34:13), Unclassified, AD 254 861.

This report is an extension of Scientific Report 1 (previous abstract). High-resolution, ground-based simultaneous measurements of ionospheric electron density and collision frequency can be made as rapidly varying functions of time. A system is proposed which uses microwave (3-Gc) radar and HF (1.5-Mc) transmitter and receiver, each at a different location. The radar operates at vertical incidence and determines electron density by measuring backscatter return. The electron-molecule collision frequency in the same spatial volume is determined by measuring the microwave-HF cross-modulation. Included is a calculation of the radar cross-section of an electron, which was found to be 10^{-28} m^2, neglecting collisions.

POLYTECHNIC INSTITUTE OF BROOKLYN, MICROWAVE RESEARCH INSTITUTE

5790 Research Report R-556-57 (PIB-484), "On the Relation Between Cone and Cylinder Green's Functions," L. B. Felsen, AF 33(038)-28634, 19 Feb 57, (21:5), Unclassified, AD 125 178.

Scalar and vector Green's functions for an infinite cylinder are derived as limiting cases of those for a semi-infinite cone. Alternative representations for cone and cylinder Green's functions are presented.

5791 Research Report R-736-59 (PIB-664; AFCRL-TN-60-978), "On the Electromagnetic Properties of Wedges and Cones with a Linearly Varying Surface Impedance," L. B. Felsen, AF 19(604)-4143, 14 Apr 60, (79:19), Unclassified, AD 246 394.

The electromagnetic behavior of wedge and cone surfaces having a linearly varying surface impedance (admittance) is analyzed. The impedance variation is such as to render the resulting two-dimensional boundary-value problems separable. Alternative representations of the formal Green's-function solutions are obtained. For certain reactive ranges of surface impedance, a new type of surface wave is found to exist. Scattering properties of a wedge with a linearly varying surface impedance are also analyzed. An asymptotic far-field evaluation of the formal solution yields a decomposition into geometric-optical, diffraction, and transition effects, whose dependence on the rate of surface impedance variation is made evident.

POLYTECHNIC INSTITUTE OF BROOKLYN, MICROWAVE RESEARCH INSTITUTE (CONT.)

5792 Research Report PIBMRI-953-61 (AFCRL-62-29), "Scattering and Guided Waves at an Interface between Air and a Compressible Plasma," A. Hessel, N. Marcuvitz, and J. Shmoys, AF 19(604)-4143, 29 Sep 61, (21:2), Unclassified, AD 273 149.

A uniform magnetic current line source is assumed to exist in free space parallel to a rigid plane surface of a compressible plasma. The plasma is assumed to have no drift, and no DC magnetic field is present. Frequency of the source is sufficiently high that ion motion is neglected, and small signal theory is used. Because the plasma is compressible, it can support two kinds of waves: transverse (optical, electromagnetic) and longitudinal (plasma, acoustic). Reflection and transmission coefficients for a plane electromagnetic wave incident on the interface from free space are calculated, and it is found that a guided wave can be excited on the surface. This surface wave does not have a high-frequency cutoff. Expressions are obtained for all field components, both electromagnetic and acoustic, that are excited by the line source.

5793 Report PIBMRI-R-452.26-64 (Progress Report 26), "A Summary of Current Research at the Microwave Research Institute," AF 49(638)-1402, 30 Sep 64, (137:-), Unclassified, AD 609 133.

A large number of studies are briefly summarized. The overall program encompasses physics, chemistry, electro-physics, and electrical engineering. A few studies pertinent to reflectivity are included. These are: "Diffraction in a Certain Stratified Medium," "Spectral and Non-Spectral Poles in Problems Concerning Radiation in Non-Homogeneous Media," "Characteristic Formulation for Non-Periodic Solutions of Mathieu's Equation," and "Geometric Optical Methods for the Calculation of Fields in Anisotropic Media."

5794 Research Report PIBMRI-1227-64 (AFCRL-65-85), "Electromagnetic Wave Propagation along a Sinusoidally Stratified Dielectric Slab," H. C. Wang, AF 19(628)-4324, Dec 64, (181:34), Unclassified, AD 612 635.

A rigorous treatment of guiding and scattering of electromagnetic waves in a periodically stratified dielectric slab located in free space. The medium of the slab is stratified by varying the permittivity as $\epsilon(z) = \epsilon_r\ [1 - M \cos(2\pi z/d)]$, where ϵ_r is the average value of ϵ_z, d is the modulation period of the dielectric constant, and M is the "modulation index" (i.e., a constant representing the amplitude of the changes in dielectric constant). The y-z plane coincides with the air-dielectric interface. The study reveals that a discrete spectrum of bound (surface) waves and leaky (complex) waves may be supported by such a configuration. Scattering properties indicate rapid fluctuations in certain frequency ranges for the space harmonics which are associated with the presence of Wood's anomalies. Dispersion curves of the stratified slab exhibit the familiar stop-band behavior due to periodicity. However, additional, previously unrecognized, stop-bands were found for certain ranges of the parameters; these are explained as the coupling of higher modes of the uniform (unmodulated) slab. When slab thickness becomes infinitely large, the configuration becomes a stratified dielectric half-space which supports only a continuous, non-discrete spectrum of waves. Three mathematical appendices deal with properties of Mathieu functions and with the accuracy of the calculation for characteristic solutions.

PURDUE UNIVERSITY

5795 Scientific Report 1 (ERD-TN-60-765), "The Scattering of a Plane Electromagnetic Wave by a Finite Cone," C. C. Rogers and F. V. Schultz, AF 19(604)-4051, 1 Aug 60, (62:35), Unclassified, AD 243 208.

The vector Helmholtz equation is solved for a plane electromagnetic wave at nose-on incidence on a perfectly-conducting cone of finite size. The solution presented is exact and in the form of an infinite series of spherical harmonics. Expansion coefficients of the series are determined by a set of an infinite number of equations involving an infinite number of unknowns. A discussion and numerical investigation of the field singularities at the tip and edge of the cone are included, as well as graphs of the associated Legendre functions of non-integral degree, $P_{\nu}^{1}(\cos \theta)$, and their first derivatives.

5796 Report TR-EE63-8 (Final Report; AFCRL-63-319), "The Scattering of Electromagnetic Waves by Perfectly Reflecting Objects of Complex Shape," F. V. Schultz, D. M. Bolle, and J. K. Schindler, AF 19(604)-4051, Jan 63, (65:16), Unclassified, AD 423 876.

A theoretical and numerical analysis was made to determine the radar cross-section of a perfectly-conducting cone of finite height using rigorous electromagnetic theory. The incomplete results obtained are compared with experimental and asymptotic theoretical results obtained elsewhere. Also investigated were methods of reducing the cross-section of a body, both by using reactive elements and by appropriately shaping the object.

5797 Scientific Report 1 (AFCRL-64-658), "The Theoretical and Numerical Determination of the Radar Cross Section of a Finite Cone," F. V. Schultz, G. M. Ruckgaber, S. Richter, and J. K. Schindler, AF 19(628)-1691, Aug 64, (45:13), Unclassified, AD 606 828.

Investigation of the radar cross-section of a finite cone. The exact solution for the scattering of a plane electromagnetic wave by a finite cone is derived, using rigorous electromagnetic theory and making no approximations. Methods of obtaining numerical cross-section results from the analytic solution by using a digital computer are discussed, and the results tabulated. About a third of the document is made up of mathematical appendices pertaining to the investigation.

5798 Report TR-EE64-18 (Scientific Report 2; AFCRL-64-762), "The Born Approximation Applied to Electromagnetic Scattering from a Finite Cone," D. B. Hodge and F. V. Schultz, AF 19(628)-1691, Sep 64, (59:32), Unclassified, AD 609 724.

The Kirchhoff approximation used in determining the fields scattered from perfectly conducting bodies is discussed and the basic assumptions implicit in this method are investigated. It is shown that this method fails to predict the depolarization phenomenon expected when obstacles lacking symmetry are considered. The Born approximation is then used to determine scattering of plane electromagnetic waves by a perfectly conducting finite cone. The second Born approximation is calculated using spherical eigenfunction expansions, but the numerical investigation indicates that this solution converges slowly.

RADIATION, INC.

5799 Report 1049-12, "Radar Reflectivity Measurements of Corner Reflector Clusters at 24 kMc," (42:-), Unclassified, AD 122 985.

Radar reflectivity of 10½-, 32-, and 52-inch corner-reflector clusters was measured at a frequency of 24 Gc and a range of 800 ft, using horizontal polarization. The document consists of thirty-nine reflectivity patterns and an abstract; details of cluster configuration and the measurement procedure and equipment are not included.

5800 Report 1147-1, "Bi-Static Radar Reflectivity Measurements of Tow Targets (MC-3, MC-5, X-4, DF4-FB8)," AF 08(616)-143, Jul 58, (27:2), Unclassified, AD 152 059.

Bistatic radar cross-sections were measured for the MC-3, MC-5, X-4, and DF4-FB8 tow targets for a continuous range of azimuth aspects at 10° increments of roll angle, and for 0° through 25° of bistatic angles at 5° increments. The transmitting antenna was linearly polarized and the receiving antenna circularly polarized; measurement frequency was 9 Gc. Instrumentation was with a low-power, X-band, CW laboratory radar system having optional polarization. Discussions are presented on the measurement system, measurement technique, calibration procedures, data error analysis, and experimental results. Also included is a block diagram of the measurement system. A total of 24 bistatic patterns are presented.

Ed: DDC-supplied reproduction was nearly illegible.

5801 Report 1147-2, "Radar Reflectivity Measurements of the ACP-1 Pod at S-Band and X-Band," AF 08(616)-143, Mar 58, Unclassified.

Note: This report was not obtained.

5802 Report 1147-3, "Radar Reflectivity Measurements of the ACP-2 Pod at S-Band and X-Band," AF 08(616)-143, Apr 58, Unclassified.

Note: This report was not obtained.

5803 Report 1190-2, "Radar Reflectivity Design Report of Monostatic Radar Target TDU-8/B," AF 08(603)-4595, Aug 58, Unclassified.

Note: This report was not obtained.

5804 Report 1190-6 (Final Report; APGC-TR-59-44), "Monostatic Radar Target TDU-8/B. Detailed Design and Testing Results," AF 08(603)-4595, (133:-), Unclassified, 1 Jun 59, AD 220 628.

Design, construction, and test phases of the monostatic radar target TDU-8/B program are described. The reflector was designed for external carriage by fighters and light bombers. The target consists of a cluster of five trihedral corner reflectors enclosed in a fiberglass housing. One reflector provides forward coverage, and the other four coverage centered on the target's broadside aspect. A series of reflectivity patterns was made of a mock-up model. Roll-angle patterns were taken for +20° to -90° relative to horizontal line of flight in increments of 10°. The patterns were reduced to median values of cross-section for 10° intervals of aspect, where median value is defined as that value exceeded for 50% of the interval. A contour plot of the radar cross-section of one side of the mock-up is included. Measurements were made at X-band with a low-power, quasi-monostatic, CW, radar-reflectivity system. The measurement technique, calibration procedure, and data presentation are described.

RADIATION, INC. (CONT.)

5805 Report 1270-1 (APGC-TN-59-44), "Radar Reflectivity Characteristics of a Modified Q-2A Pod," AF 08(635)-501, 1 Jul 59, (57:-), Unclassified, AD 220 385.

Monostatic and bistatic radar-reflectivity characteristics were measured for a modified Q-2A wing tip pod at 9.11 Gc. Monostatic measurements were taken for a continuous range of azimuth aspect at 1° increments of all roll angles from +5° to -5°. Roll angles of plus and minus 10°, 15°, and 90° were also measured. Bistatic measurements were made for a continuous range of azimuth aspects at 5° increments of roll angle from +15° to -15°, and for roll angles of ±2.5°. A total of 42 polar patterns are presented. The instrumentation radar was a low-power, X-band, CW, laboratory system having optional polarization.

5806 Report 6109-2, "Feasibility Study of Reflectors for Light Aircraft," DA 36-039 SC-73074, Oct 56, Unclassified.

Note: This report was not obtained.

5807 Report 6109-3 (Final Report), "Feasibility Study of Radar Reflectors for Light Aircraft," DA 36-039 SC-73074, 20 Apr 57, (56:9), Unclassified, AD 141 388.

The project was performed to determine the feasibility of incorporating passive reflectors into typical light aircraft to enhance their radar reflectivity up to the level of a C-47 for all aspects. The Final Report contains essentially all of the pertinent information contained in Quarterly Reports 1 (Abstract 2561), and 2 (not obtained). Radar cross-sections of the C-47 and nine commercial aircraft were determined in order to establish criteria for the enhancement devices.

Factors that perturb radar reflectivity as functions of aspect angle and time are discussed in a section on response patterns from complex targets. Targets investigated as enhancement devices included: (1) a $\lambda/2$ dipole, (2) an array of dipoles, (3) a sphere, (4) trihedral and dihedral corner reflectors, and (5) Luneburg-lens reflectors. Based upon cross-section, polarization, and angular coverage, the dihedral and trihedral corner reflectors and the Luneburg-lens reflector were chosen as being most applicable.

The responses of specific Luneburg-lens and dihedral reflectors were measured with models for L-, S-, and X-bands, and possible locations on the aircraft are considered. The study indicates that enhancement is feasible with both fabric and metal aircraft at X-band and is conditional for both types at S-band and for fabric craft at L-band; enhancement is not feasible for metal aircraft at L-band. It is further concluded that it is not feasible to meet fully the specified requirements on frequency, polarization, and aspect coverage.

5808 Report 6458 (RADC-TR-61-181), "Static Reflectivity Measurements of 12 Foot Diameter Inflatable Satellite," 1 Jul 61, (17:-), Unclassified, AD 262 448.

The bistatic radar cross-section of 12-foot-diameter models of the Echo balloon was measured at 3.3 Gc and 24 Gc to simulate the response of the full-size balloon at frequencies of 400 and 2270 Mcs, respectively. At 24 Gc, the balloon median response is essentially constant at the theoretical value out

RADIATION, INC. (CONT.)

5808 (Cont.)

to 150° bistatic angle with either horizontal or vertical polarization. At 3.3 Gc, the median response for vertical polarization is essentially constant at the theoretical value to 130° bistatic angle, and increases at 140°-150°. With horizontal polarization, the median value varies with the sphere response for the entire range of bistatic angles from 90° to 150°.

5809 Report 6551, "Radar Reflectivity Measurements on TRAILBLAZER II Configuration," Subcontract from MIT/LL under AF 19(604)-7400, 16 Jul 62, Unclassified.

Note: This report was not obtained.

5810 Letter Report 6663, "Radar Reflectivity Measurements of the SLAM Missile at 3000 and 1200 Mc," Subcontract from Chance-Vought under AF 33(657)-8686, 9 Nov 62, Unclassified.

Note: This report was not obtained.

5811 Letter Report 6702, "Radar Reflectivity Measurements of the QF-104 Aircraft at 4800 mc," Subcontract from Lockheed under AF 04(606)-8012, 5 Dec 62, Unclassified.

Note: This report was not obtained.

5812 Letter Report 6768, "Radar Cross Section Measurements for MIT/ Lincoln Laboratories on INDIA Models," Subcontract from MIT/LL under AF 19(628)-500, 16 Sep 63, Unclassified.

Note: This report was not obtained.

5813 "Experimental Investigation of Chaff Transmission in the 1300 to 1800 Mc Frequency Range," L. H. Bauer and L. F. O'Kelley, DA 36-039 SC-88897, Unclassified.

Report	Description	Date	Pages:Ref	AD No.
1	1st Quarterly	30 Sep 61	40:2	268 756
2	2nd Quarterly	31 Dec 61	181:2	273 111
3	3rd Quarterly	31 Mar 62	92:0	275 622
4	Final Rpt, Vol. II*	30 Jun 62	90:0	283 319

*Volume I was not obtained.

This program studied the feasibility of communicating between two ground points by reflection from chaff clouds in the frequency range from 1300 to 1800 Mc. Site separations of 4-6 miles and 52 miles were used with the AN/BRC-50 radio relay system. Field tests provided data on transmission loss, frequency dependence, diversity polarization, information bandwidth, meteorological effects connected with forward-scatter from a chaff cloud, and bistatic cross-sections σ_{12} of the chaff clouds. Chaff was dispensed in 10-lb bundles at 15,000 ft or less.

RADIATION, INC. (CONT.)

5813 (Cont.)

Report 1 gives test setups and instrumentation, and includes preliminary data on chaff fall rate, cloud size, and calculated bistatic cross-sections.

Report 2 describes the results of six drops which showed that: (1) bistatic cross-section of the chaff cloud was characterized by a rapid increase to a constant value shortly after the chaff drop; (2) measured median σ_{12} was 2000-5000 m^2 for a chaff cloud containing 3.75×10^6 dipoles; (3) σ_{12} is proportional to the number of dipoles; (4) chaff fall rates ranged from approximately 100 to 200 fpm at altitudes of 5000 to 10,000 ft; (5) fall rate decreased with decreasing altitude; and (6) σ_{12} was polarization sensitive, i.e., rotation of the receiving antenna with fixed transmitting-antenna polarization produced a 2.5-dB variation in σ_{12}.

Report 3 is a continuation of the work begun under Report 2. Results showed that σ_{12} increases to a maximum value and then remains constant until scatterers are removed from the antenna beam by dispersion, and that no aspect sensitivity is displayed. Power spectra show the fluctuations of the scattered signal to be in the range 0 to 5 cps. The probability distribution of received power was essentially Rayleigh.

Report 4, Vol. II of the Final Report, consists almost entirely of data on cloud configuration, fall rate, and drift rate based on ten drops using the M-33C search and tracking radars. The data were used to compute transmitter-to-cloud and receiver-to-cloud slant ranges required to compute σ_{12}. Effects of wind shears on cloud configuration are reported.

These reports are valuable because they deal with a topic about which little information has been available, namely, the characteristics and bistatic cross-sections of chaff clouds at altitudes less than 15,000 ft.

5814 Final Report, "Investigation of Chaff Communications at 5,000 Mcps," L. H. Bauer, C. J. Palermo, and B. L. Lewis, DA 36-039 AMC-00045(E), 31 May 63, (155:10), Unclassified, AD 420 192.

An experimental and theoretical program to investigate the use of chaff clouds for communication at 5.652 Gc beyond the line-of-sight. The theoretical phase considered: (1) calculation of bistatic cross-sections of the cloud as functions of polarization and frequency; (2) modulation and bandwidth characteristics for PCM, AM, and FM; (3) the advantages of space, polarization, and frequency diversity to avoid the effects of fading caused by changes in bistatic cross-section; (4) the problem of acquiring and tracking the drifting and dispersing cloud with high-gain antennas; and (5) antenna size and chaff-dispensing system. Average bistatic cross-sections were calculated by multiplying the average cross-section of a single dipole by the number of dipoles. Scatterer types considered were: halfwave dipoles, square and circular plates, and circular loops. Random horizontal and vertical distributions were assumed. Calculations showed that bandwidths of about 10% of the carrier frequency were possible.

Effects of chaff cross-section characteristics on modulation and bandwidth were calculated, assuming Rayleigh fading. Calculations showed that for

RADIATION, INC. (CONT.)

5814 (Cont.)

PCM/AM, dual space diversity can reduce the effects of deep fading. Effects of antenna beamwidth on the bistatic cross-section were also considered. The experimental tests used a 52-mile site separation and dispersal at 12,000 to 14,000 ft near the receiver site, five chaff drops were involved. Measured and predicted cross-section values agreed to within experimental error.

5815 "K-Band Bi-Static, and X-Band Monostatic Pulse Type Radar Echo Measurement Facilities," AF 33(600)-25107, Nov 56, Unclassified, AD 59 113.

Note: This report was not obtained.

5816 Preliminary Report, "ECHO Balloon Radar Cross Section Measurements," NAS5-890, 27 Apr 61, Unclassified.

Note: This report was not obtained.

5817 Preliminary Report, "Static Radar Reflectivity Measurements on the ECHO II Balloon," NAS5-890, 3 Oct 61, Unclassified.

Note: This report was not obtained.

5818 Letter Report, "Static Radar Reflectivity Measurements on a Dodecahedron Balloon Model," NAS5-890, 8 Feb 62, Unclassified.

Note: This report was not obtained.

5819 Preliminary Report, "Backscattering from a Spherical Cap," NAS5-890, 26 Sep 62, Unclassified.

Note: This report was not obtained.

5820 Final Report, "Reflectivity Characteristics of ECHO Balloons," NAS5-890, 2 Oct 62, Unclassified.

Note: This report was not obtained.

5821 Addendum to Final Letter Report, "Radar Reflectivity Measurements of the SLAM Missile at 3000 and 1200 mc," Subcontract from Chance-Vought under AF 33(657)-8686, 30 Nov 62, Unclassified.

Note: This report was not obtained.

5822 "List of Published Reports. Static and Dynamic Radar Reflectivity Measurements," 20 Apr 64, (17:150+), Unclassified.

Listing of over 150 classified and unclassified reports on radar-reflectivity measurements published by Radiation between 1953 and 1964. Entries are arranged chronologically by contract under the main divisions of static and dynamic measurements.

RADIO CORPORATION OF AMERICA, MISSILE AND SURFACE RADAR DIVISION

5823 DAMP Physics Report, "Down-Range Anti-Ballistic Measurement Program. Microwave Detection and Discrimination of Hypersonic Re-Entry Vehicles. Volume 1," DA 36-034 ORD-2549 and DA 36-034 ORD-2683, 26 Feb 60, (189:-), Unclassified, AD 240 561.

RADIO CORPORATION OF AMERICA, MISSILE AND SURFACE RADAR DIVISION (CONT.)

5823 (Cont.)

Volume 1 of this publication deals with the electrical properties of re-entry plasmas, and with flow fields in the plasmas. It contains essentially no material that is directly related to radar reflectivity. Volumes 2 and 3 are Confidential; for abstracts, see the next volume of this bibliography.

Note: Extensive studies of re-entry phenomena were made from 1958 to 1964 under the DAMP program (Down-Range Anti-Ballistic [or Anti-Missile] Measurement Program). Pertinent unclassified reports that were obtained are abstracted below. Abstracts of classified reports may be found in other volumes of this bibliography.

5824 DAMP Physics Report, "Down-Range Anti-Ballistic Measurement Program. Electromagnetic Wave Propagation and Radiation Characteristics of Anisotropic Plasmas," DA 36-034 ORD-3144RD, ARPA Order 51, Apr 60, (-:23), Unclassified.

(BD-1343) This report is a study of electromagnetic properties of homogeneous anisotropic plasmas. The propagation characteristics of electromagnetic waves in anisotropic plasmas are examined for propagation parallel to and perpendicular to the applied DC magnetic field. The existence of very-low-frequency pass-bands due to ion effects is noted. Faraday rotation due to the earth's magnetic field is considered for the ionosphere and the plasma sheath of a re-entry vehicle. A generalized and exact form of Kirchhoff's law is used to obtain the absorptivity of a plasma from its electromagnetic properties. The absorptivity of an isotropic and anisotropic plasma slab is computed for normal incidence, and the effects of electron collision frequency, slab thickness, stop-bands and boundary effects on the radiation spectrum are presented.

5825 DAMP Technical Monograph 62-04, "Down-Range Anti-Missile Measurement Program. Reflection of a Plane Wave by a Cylinder of Arbitrary Cross Section," J. Steinberg and B. Wolf, DA 36-034 ORD-3144RD, Nov 62, (-:21), Unclassified.

(BD-3890) A mathematical method is presented for approximating a solution to the wave equation, applicable to physical problems in radar. The first section outlines theoretical foundations; the second suggests a procedure for solving typical problems; the last presents an example of procedure application by computing the field reflected from an elliptic cylinder.

5826 DAMP Technical Monograph 62-07, "Down-Range Anti-Missile Measurement Program. Existing Solutions for Interaction of Electromagnetic Waves with Plasma of Simple Geometries," K. A. Graf and M. P. Bachynski, DA 36-034 ORD-3144RD, ARPA Order 51, Jun 62, (29:33), Unclassified, AD 277 201.

A survey and summary of the known solutions for reflection, transmission, and scattering of electromagnetic waves by plasmas of simple shape. Most of the work discussed falls under either the wave-equation method or the weak-scatter method. Treatments based on the wave equation include: (1) semi-infinite plasmas with varying electron gradients and distributions; (2) uniform and non-uniform plasma slabs; and (3) uniform, cylindrical plasmas in a static, axial magnetic field. The weak-scatter theory is used on: (1) plasmas with prolate-spheroidal Gaussian distribution, (2) line plasmas, and (3) spherical satellites

5826 (Cont.)

with plasma sheaths. Also treated are interactions with dense spherical inhomogeneities, plasma-coated spheres, plasma-coated long thin bodies, and reflections from dense "Gaussoids" (metal prolate spheroids). The 33 references include both classical papers and recent results.

Note: The authors are with RCA Victor Ltd. (Canada).

5827 DAMP Technical Monograph 62-20, "Down-Range Anti-Missile Measurement Program. Specular Reflection from a Plasma-Clad Infinite Cylinder of Arbitrary Cross-Section," A. D. Gottlieb and J. Steinberg, DA 36-034 ORD-3144RD, ARPA Order 51, Dec 62, (-:20), Unclassified.

(BD-3813) An expression is developed for the strength of an electromagnetic field reflected specularly from an infinite plasma-clad cylinder of arbitrary cross-section. The technique consists of solving the differential equation for the zero-order term (geometrical-optics term) of the asymptotic expansion for the time-reduced electric field along a reflected ray. The solution is then applied to the case of a cylinder of elliptical cross section.

5828 DAMP Technical Monograph 62-21, "Down-Range Anti-Missile Measurement Program. Microwave Scattering from Supersonic Plasma Flow-Fields," A. I. Carswell, DA 36-034 ORD-3144RD, Dec 62, (148:64), Unclassified, AD 407 259.

A laboratory investigation of the backscattering of microwaves from supersonic plasma flow streams, to provide experimental data necessary for understanding the radar return from re-entry vehicles. Measurements discussed include: mapping of electron density in supersonic streams; X-band and K-band backscatter measurements on laminar and turbulent supersonic plasma streams; study of the effects of flow turbulence on scattering properties of plasma; investigation of the frequency content of the fluctuating microwave signal scattered from turbulent plasma; and study of the resonance phenomenon observed in the scattering of microwaves by cylindrical plasma columns. Application of the results to re-entry plasmas is also discussed. A comprehensive bibliography is included.

Note: The authors are with RCA Victor Ltd. (Canada); this report was also issued by RCA Victor, see Abstract 5857.

5829 DAMP Technical Monograph 62-24, "Down-Range Anti-Missile Measurement Program. Electromagnetic Wave Scattering by Plasma Systems with Applications to the Re-Entry Problem," A. I. Carswell, J. Nuttall, and G. Paquette, DA 36-034 ORD-3144RD, ARPA Order 51, Dec 62, (116:105), Unclassified, AD 295 045.

This report is an excellent introduction to its subject. It is well written, and summarizes concisely a great deal of information on the complexities of the problem of scattering by plasmas, and on the various theoretical approaches that have been used to study it. Although attention is confined largely to solution of the field equations in the presence of a medium having specified macroscopic parameters (e.g., conductivity and dielectric constant), the derivation of these parameters from the microscopic composition of the plasma is also considered.

RADIO CORPORATION OF AMERICA, MISSILE AND SURFACE RADAR DIVISION (CONT.)

5829 (Cont.)

The first section considers the basic nature of the plasma and of its interaction with electromagnetic waves without boundary effects; this includes the homogeneous, isotropic plasma, the inhomogeneous plasma, and the anisotropic plasma. A second section examines the theory of scattering in somewhat more detail, including the effects of having sharp boundaries, of stratifications in the plasma, and of a continuous gradient of dielectric constant. A brief discussion on cylindrical geometry is followed by a survey of the several approximation techniques that have been utilized and their regions of application and limits of validity. The third section deals with applications to re-entry plasmas, primarily meteor trails. The report includes a comprehensive bibliography.

5830 DAMP Technical Monograph 63-03, "Down-Range Anti-Missile Measurement Program. Radar Cross Section of Conducting Bodies of Revolution," J. Steinberg and A. D. Gottlieb, DA 36-034 ORD-3144Z, ARPA Order 51, Apr 63, (30:3), Unclassified, AD 406 774.

Development of a method for determining the monostatic radar cross-section of any conducting convex surface of revolution generated by rotating a curve $f(x,y) = 0$ about the x-axis to form a closed surface. The technique is used to solve the differential equation for the zero-order term (geometric-optics term) of the asymptotic expansion for the time-reduced electric field along a reflected ray. When the method is applied to the spheroid, the following expression was developed which represents the variation in cross-section of spheroids for any aspect angle:

$$\sigma(\delta) = \frac{\pi\epsilon^4 a^2}{(\epsilon^2 \sin^2\delta + \cos^2\delta)^2} ,$$

where the propagation vector is normal to the z-axis and makes an angle δ with the x-axis, $\underline{a}$ is the major-axis radius of the prolate spheroid, and ϵ is the minor-axis radius divided by $\underline{a}$.

5831 DAMP Technical Monograph 63-05, "Down-Range Anti-Missile Measurement Program. Specular Reflection of a Plane Wave by a Plasma-Clad Conducting Body of Revolution," A. D. Gottlieb and J. Steinberg, DA 36-034 ORD-3144Z, Aug 63, (21:5), Unclassified, AD 416 212.

In this theoretical treatise, an expression is developed for the far-field strength of an electromagnetic field reflected specularly from a plasma-clad conducting body of revolution. The plasma is considered to be uniform, homogeneous, and isotropic; Maxwell's equations are used with appropriate boundary conditions.

5832 DAMP Technical Monograph 63-12, "Down-Range Anti-Missile Measurement Program. The Back Scatter from Rough Surfaces Using Huygens' Principle," R. Ruffine, DA 36-034 ORD-3144Z, Dec 63, (30:5), Unclassified, AD 430 233.

Work of Davies (see Abstract 3309J) based on the Kirchhoff approximation for geometrical optics is extended to include a contribution from the component of the surface normal which is parallel to the average surface. Relevant

5832 (Cont.)

integral equations for scattering of scalar and electromagnetic waves are constructed. The cross-section for a bumpy strip in the geometric-optic limit is calculated. The primary result of the theory is to multiply Davies' results for the incoherent wave by $1/\cos^4\psi$, where ψ is the angle between the radar line of sight and the normal to the average surface.

5833 DAMP Technical Monograph 63-16, "Down-Range Anti-Missile Measurement Program. Backscattering of Electromagnetic Waves by Rough Conducting Surfaces and Overdense Wakes," R. M. Lewis and J. B. Keller, DA 36-034 ORD-3144Z, ARPA Order 51, Dec 63, (13:3), Unclassified, AD 426 204.

An exact solution is developed for the problem of scattering of an electromagnetic wave by a perfectly conducting slightly rough surface, i.e., one for which the deviations from a smooth surface are small compared to λ. The Kirchhoff method is used to obtain the backscattered field, and the statistical properties of that field are derived from the statistical properties of the corresponding random surface. Then the field statistics are expressed as functions of aspect angles by integrals over the smooth surface. Results are specialized by assuming the smooth surface to be a surface of revolution. Application is made to the case of backscattering from a rough circular cylinder, which could represent an overdense ionized wake.

5834 DAMP Technical Monograph 64-01, "Down-Range Anti-Missile Measurement Program. Cross-Polarized Electromagnetic Backscatter," R. S. Ruffine and D. A. deWolf, DA 36-034 ORD-3144Z, ARPA Order 51, Jun 64, (25:4), Unclassified, AD 445 295.

The cross-polarized, incoherent backscatter cross-section of a turbulent, under-dense plasma is derived using the second Born approximation. The work is aimed at testing Booker's assumption (see Abstract 7690J) that the first Born approximation is applicable to such cross-section calculations. An appreciable cross-polarized component will indicate the failure of the first Born approximation.

Note: The following unclassified DAMP Technical Monographs were not obtained for abstracting, but may contain pertinent material:

DTM 62-01 "Analysis of the Far-Field Wake Behind an Oscillating Re-entry Vehicle"
DTM 62-13 "Asymptotic Solution of Maxwell's Equation in Inhomogeneous Isotropic Media"
DTM 62-16 "Data Techniques Evaluation"
DTM 62-18 "Ambiguities in Radar Signal Measurements of Extended Targets"
DTM 62-19 "Determination of Radar Bias Errors"
DTM 62-37 "Generation of the Oscillating Wake Analysis"
DTM 62-28 "Further Results for the Oscillating Wake"
DTM 62-29 "Hypersonic Axisymmetric Turbulent Wakes Including Rate Chemistry"
DTM 62-31 "Description of the IBM 7090 Programs for the Calculation of Properties in the Far Field Wake Behind an Oscillating Re-entry Vehicle"
DTM 62-32 "On the Compressible Elliptic Wake"
DTM 62-33 "Investigation of Phenomena Influencing Hypersonic Wake Analysis"
DTM 62-34 "Hypersonic Axisymmetric Laminar Wakes Including Rate Chemistry and Streamwise Pressure Gradients"

RADIO CORPORATION OF AMERICA, MISSILE AND SURFACE RADAR DIVISION (CONT.)

5834 (Cont.)

DTM 63-04 "Differential Equations for the Field Amplitude in Inhomogeneous Media"

DTM 63-11 "Discussion of Electromagnetic Wave Interaction in a Lossy Uniform Magnetoactive Plasma, and Application to the Re-entry Blackout Problem, October 1963"

5835 Final Report, Volume 1, "Down-Range Anti-Missile Measurement Program (DAMP)," ARPA Order 51, May 64, (277:0), Unclassified, AD 444 239.

Summary of unclassified portion of the DAMP program, covering April 1958 to May 1964. Contracts for the several phases of development and operation include DA 36-034 ORD-2683RD, -3143RD, -3144RD, -3741RD, -3143Z, -3144Z, and -3741Z. Some 171 reports have been issued under these contracts and a bibliography of these is included. However, identification of the reports and their content is limited to unclassified title and report type, classification, and number; DDC identification and availability are not given.

Although this final report covers a period of six years in which a vast amount of information was derived, some fairly detailed discussions are included. A section on "down-range achievements" deals in general terms with observations that were made on re-entering bodies; topics discussed include signature studies, wake length, and discrimination. Other sections report on laboratory measurements of cross-sections for small targets of various shapes, and on data handling. A section of just over 100 pages discusses laboratory studies on plasma. The topics involved include scattering from supersonic plasma flow-fields, EM wave interaction with plasmas of simple geometry, and scattering from plasma columns.

5836 RADC-TDR-62-178, "Cross-Section Analog Computer Manual," H. Scheuer, Jr., AF 30(602)-2359, 26 Mar 62, (72:11), Unclassified, AD 454 752.

Description of a technique for simplifying the analysis of radar target signatures. The fundamental input needed for target-signature analysis, a time record of target cross-section, is generally not available from instrumentation radars and cannot be derived from existing records due to lack of calibration data. The discussion shows how a general-purpose analog computer can be employed to extract a record of target cross-section from the output of an existing radar without any modification to the radar. This is accomplished by automatically modifying the received signal with range and calibration data. A sample analog-computer program developed for use with the AN/FPS-16 radar is described. The discussion and description is in sufficient detail to enable the reader to apply the technique to most instrumentation radars.

5837 "Scale Model Radar Cross Section Data. Space-track O & M Signature Analysis Program," L. H. Lenert, AF 19(628)-536, Jan 63 [Revised 31 May 63], (79:-), Unclassified, AD 460 987.

Radar cross-section curves are given for various idealized shapes representing satellite payloads and missile tanks. The shapes are bodies of revolution. Both simple shapes (cones, spheres, cylinders, etc.) and complex combinations of simple shapes are considered. Curves presented for the simple bodies are σ vs. aspect angle, with various transmit and receive polarizations; complex-body curves show both σ and phase angle vs. aspect angle. Data comprise

RADIO CORPORATION OF AMERICA, MISSILE AND SURFACE RADAR DIVISION (CONT.)

5837 (Cont.)

about 90% of the report; the original data were obtained through scale-model measurement programs at Radiation, Incorporated (no reference is given). Frequency was that for the AN/FPS-49 radar (exact value not given).

5838 Final Technical Summary Report, "Tradex Instrumentation Radar," DA 36-034 ORD-3063Z, ARPA Order 49-60, 15 Feb 63, (215:7), Unclassified, AD 414 117.

In this report, the instrumentation design and operational concepts of the TRADEX (Target Resolution And Discrimination EXperiments) radar are described in detail. The TRADEX system is a dual-frequency, high-power, phase-coherent tracking radar, using polarization diversity and pulse compression. It incorporates a design philosophy that should enable it to gather a maximum amount of raw data on target objects from the radar signal return. The two systems operate at frequencies of 425 and 1320 Mc, with peak powers of 4 MW and 1 MW, respectively. System checkout tests used such targets as balloon-borne spheres, bore-sight tower, orbiting bodies, and specific ICBM missiles. Data from these tests are presented as well as from tests on the Echo-I orbiting satellite.

5839 Re-entry Analysis Technical Monograph 64-08, "Scattering from a Turbulent Overdense Surface," J. Jarem, DA 01-021 AMC-10963Z, ARPA Order 51, Dec 64, (42:9), Unclassified, AD 456 699.

Scattering of microwaves from a turbulent over-dense plasma surface is considered, where the plasma interference is represented as a real random process with zero mean value and a covariance function representing homogeneous turbulence. The energy scattered from the plasma surface is related to the incident field by the Kirchhoff approximation of the Stratton-Chu stochastic integral, and the scattered field is calculated for vertically and horizontally polarized incident plane waves.

Explicit results are obtained for the coherent and incoherent scattered radiation from overdense turbulent plasma surfaces with Gaussian and exponential correlation functions. The incoherent component is expressed in terms of so-called incoherent scattering functions which are tabulated for an extensive range of correlation lengths and surface roughness parameters. For the case of the Gaussian correlation function, the incoherent scattering is also computed for an anisotropic surface. The theory is compared with published experimental results for bistatic scattering and backscattering from rough surfaces and re-entry wakes.

RAND CORPORATION

5840 Memorandum RM-748, "Phase Coherence of Reflections from Scatterers," E. Reich, 18 Dec 51, (8:0), Unclassified, AD 116 568.

A target is assumed to consist of a single specular reflector of fractional target area A and a large collection of scatterers oriented at random phase with respect to the transmitter having a total fractional area of 1-A. The phases of reflector and scatterers are assumed to change independently between observations, such that the phase changes have zero mean value and specified standard deviation. The expected phase difference between successive reflections of an incident sine wave from this target assembly is computed. Results show that the standard deviation of phase shift for the total signal between reflections does not differ too greatly from the standard deviation of the individual target components between observations.

RAND CORPORATION (CONT.)

5841 Memorandum RM-3251-PR, "Radar Echo from Re-entry Vehicles," H. Weil, AF 49(638)-700, May 63, (43:27), Unclassified, AD 406 204.

The computation of radar echo from re-entry vehicles was studied primarily to indicate the sort of estimates that can be made using presently available results from the gasdynamic theory of wakes and from electromagnetic theory. Numerical results for low-frequency reflectivities and cross-sections are obtained for a particular computed re-entry wake viewed broadside. The resulting cross-sections, although orders of magnitude greater than that of the vehicle without wake, are smaller than the broadside geometric cross-section of the overdense wake region. Some specific electromagnetic problems are outlined, the solution of which would aid in obtaining results better than the crude estimates presently achievable.

5842 Memorandum RM-3440-PR, "Incoherent Scattering of Radio Waves by a Plasma," D. F. DuBois and V. Gilinsky, AF 49(638)-700, Jan 63, (19:12), Unclassified, AD 296 931.

The incoherent scattering of radio waves from a hot plasma is computed, using the diagrammatic techniques of quantum electrodynamics. This method simplifies previously obtained results and permits extensions to include the effects of close collisions. It is shown how the standard results are obtained simply from a theory of many-body electromagnetic interactions.

5843 Memorandum RM-3466-ARPA, "Gradient Scattering from Missile Wakes," R. L. Kirkwood, SD-79, ARPA Order 189-61, Feb 63, (19:3), Unclassified, AD 403 769.

An approximate relation for estimating the echo area of an underdense laminar missile wake is developed from two different points of view. First, the wake is considered as a continuum and the radar return is determined from the gradient of the refractive index. Next, the wake is considered as a collection of particles and the return is computed as the sum of the returns from the individual electrons. It is shown that the two results are essentially equivalent. The resulting formula involves only a single integral over the reflection points at which the incident wave is normal to the surfaces of constant refractive index. It should be applicable when the radii of curvature of these surfaces are appreciably greater than λ and there are no strong local fluctuations of refractive index in any region the size of a wavelength.

5844 Memorandum RM-3573-ARPA, "The Scattering of Electromagnetic Waves from Plasma Cylinders," P. Greifinger, SD-79, ARPA Order 189-61, Unclassified.

Part	Date	Pages:Refs	AD No.
I	Aug 63	33:4	427 062
II	Jul 64	40:-	444 792

Part I reviews the theory of scattering of electromagnetic radiation in the transverse magnetic mode by infinite plasma cylinders with radially varying electron-density distributions. Techniques for calculating the scattering cross-section are described, with special emphasis placed on short-wavelength scattering. Specific calculations of the backscattering cross-section are made in the geometrical-optics limit and in the Born-approximation limit for several monotonically decreasing electron-density distributions having zero slope on the cylinder axis. The cross-section in the region of transition

RAND CORPORATION (CONT.)

5844 (Cont.)

from underdense to overdense plasma was programmed and computed on the IBM 7090 for a Gaussian and for a quadratic electron distribution, for wavelengths equal to 1/10 and 1/100 of the cylinder radius.

Part II deals with the long-wavelength limit of the same scattering problem. The irradiating wave is assumed to be plane and to be incident normally on the cylinder, polarized parallel to the cylinder axis; the electron density distribution is monotonic. Techniques for calculating the scattering cross-section are described for both increasing and decreasing electron-density distributions. Resonance phenomena peculiar to increasing distributions are discussed in some detail with specific numerical examples. Also included is a résumé of methods for calculating the scattering cross-section of monotonically decreasing electron-density distributions when irradiated by waves of arbitrary wavelength. Examples are given for the Gaussian electron distribution.

5845 Memorandum RM-3649-ARPA, "A Simplified Model of the Laminar Wake of a Hypersonic Body for Studying Electromagnetic Effects," R. D. Engel, SD-79, ARPA Order 189-61, May 63, (42:9), Unclassified, AD 406 879.

Presents a simplified analytical model for investigating such characteristics as electron density, collision frequency, velocity, and temperature of the wake of a body moving at hypersonic speed through the atmosphere. The model furnishes information necessary for studying electromagnetic scattering from the wake, but no discussion of reflectivity or scattering is included.

5846 Memorandum RM-3696-PR, "The Plasma Resonance in Incoherent Scattering of Radio Waves from a Fully Ionized Plasma," V. Gilinsky and D. DuBois, AF 49(638)-700, Jul 63, (17:6), Unclassified, AD 411 807.

Study of the detailed shape of the plasma resonance in the spectrum of radio waves incoherently scattered from a hot plasma. The calculation includes exactly the lowest-order effects of close collisions in the limit of long wavelength and high plasma temperature. However, the results are applicable to some experiments to be performed on incoherent scattering of radar beams from the ionosphere. Although the magnetic field is neglected, this is a good approximation at high frequencies. The effect of collisions with neutral atoms is also neglected and this restricts the validity of the results to altitudes above 200 km. A diagrammatic description of electrical interactions of charged particles is used and a weakly coupled, high-temperature plasma in thermodynamic equilibrium is assumed.

5847 Report R-393-PR, "Light Scattering on Partially Absorbing Homogeneous Spheres of Finite Size," D. Deirmendjian and R. J. Clasen, AF 49(638)-700, Feb 62, (-:16), Unclassified.

(BD-6633) This report discusses quantitative results based on the exact solution of the following theoretical problem: for a sphere of arbitrary size, composed of homogeneous material with a finite dielectric constant and conductivity, receiving a constant flux of plane electromagnetic waves of given frequency, state of polarization, and direction, find the total amount of energy absorbed and scattered by the sphere, as well as the specific intensity and the state of polarization of the energy scattered in a given direction, at a large distance from the sphere. Mie obtained a complete analytical solution on the basis of Maxwellian field theory, but the present study gives accurate

RAND CORPORATION (CONT.)

5847 (Cont.)

numerical results, based on Mie's expressions, for a wide range of basic parameters not treated earlier. Examples illustrate the effects of variation in dielectric and conducting properties on the total scattering and absorption cross sections as a function of the relative size of the sphere, as well as on the differential amplitude, intensity, and polarization of the scattered energy.

The work was undertaken to study planetary atmospheres containing particles of various sizes and types, whose characteristics are to be determined by means of the reflected and transmitted visible and infrared sunlight. Results, after proper scaling, are applicable to spheres receiving electromagnetic radiations of much lower frequencies, such as microwaves.

5848 Report R-407-PR, "Tables of Mie Scattering Cross Sections and Amplitudes," D. Deirmendjian, AF 49(638)-700, Jan 63, (34:3), Unclassified, AD 295 148.

This report is a companion and extension to an earlier report by Deirmendjian (see previous abstract). The author recognizes the ease with which Mie scattering cross-sections and amplitude can be obtained using a digital computer and acknowledges the virtually impossible problem of tabulating all possible ranges. It is suggested that a judiciously chosen set of tables can be useful both for those who do not have ready access to computer time and for checks on computer programs. Twenty-seven tables are given. Table usage and accuracy of values are discussed. The complex index of refraction, m, is allowed to vary from $m = 1.29 - j0$ to $m = 5.8368 - j3.0046$, while the parameter x ($= 2\pi r/\lambda$) is varied in increments of 0.5 from 0.5 to 25.0 in some cases; r is the geometric sphere radius. The scattering cross-sections and complex amplitudes are tabulated only at representative intervals in the range of m, and the increment and excursion of x change from table to table.

RAYTHEON COMPANY (WALTHAM)

5849 "Ground Wave Radar," W. A. Whitcraft, Jr., AF 19(122)-286 and subcontract from MIT/LL, Unclassified.

Eng. Rpt.	Date	Pages:Refs.	AD No.
1-1	8 Jun 53	21:0	223 149
1-2	8 Sep 53	24:0	223 150
1-3	8 Dec 53	32:1	223 151
1-4	8 Mar 54	32:1	223 152
2-1	8 Sep 54	50:2	223 153
2-2	8 Mar 55	73:3	223 154
3-1	8 Sep 55	34:0	223 155

This program was aimed at determining the feasibility of detecting low-flying aircraft below the line of sight with the aid of an HF (5 to 30 Mc) radar previously constructed by Raytheon. The engineering reports tabulated above deal almost entirely with problems of equipment and experiments, and contain no material of consequence relating to the theory of the proposed system. Attempts were made to measure the radar cross-sections of the B-29, B-47, and P-2V aircraft at frequencies of about 2.8 and 18.4 Mc. Numerous difficulties were encountered, and the few cross-sections tabulated do not inspire confidence. Diurnal fluctuations in measured field strength over a mixed land-sea propagation path were thought to show some correlation with tidal periodicity.

RAYTHEON COMPANY (WALTHAM) (CONT.)

5850 Final Report (AFCRL-923), "Studies in Ionospheric Propagation," AF 19(604)-5230, 30 Jun 61, (110:8), Unclassified, AD 268 270.

Four separate areas are reported: (1) the spectrum of HF backscattered signals and a related study of the phase stability on forward-propagated paths; (2) observation of around-the-world signals on 14 to 27 Mc; (3) application of PPI and interferometer techniques on ground backscatter to study sporadic E; and (4) development of a punched-paper-tape system to collect propagation data for later analysis by digital computers.

In the first area, a spectrum analysis was made of backscattered returns from 22-Mc pulse transmission originating from South Dartmouth, Massachusetts. Disturbed ionospheric conditions resulted in unusual and recognizable spectrum changes, but tests made to compare the effect of land and sea areas on the backscatter spectrum were inconclusive. Phase stability was measured by phase-coherent detection methods, for both normal and disturbed states of the ionosphere, over links from South Dartmouth to the Canal Zone and to Grand Bahama Island. Observed and theoretically derived phase-path variations are compared. The theory assumed the validity of ray theory for ionospheric propagation and a parabolic distribution of ion density vs. height. Experimental frequency shifts of less than 3 cps were observed, and most values fell in the 1-2 cps range; disturbed states gave abrupt shifts of 2-4 cps.

RCA SERVICE COMPANY, INC.

5851 Technical Memorandum 63-5, "MOD IV Radar Performance on Minuteman Launches," D. E. Halter and A. E. Hoffmann-Heyden, AF 08(606)-5300, 12 Feb 63, (21:3), Unclassified, AD 428 938.

The AMR MOD IV (X-Band) radars at Cape Canaveral have rendered tracking coverages consistently shorter than expected during Minuteman missile launches. A rapid decay of the missile's reflectivity at aspect angles below 6° was determined as the primary cause and is attributed to interaction by the exhaust flame. The trend of signal losses indicates that the MOD IV coverages on the Minuteman cannot be increased by small improvements of radar rf performance, but rather by radar operation from locations which maintain aspect angles above 6°. To demonstrate the MOD IV radar rf performance, tracks of a standard sphere were evaluated; these compared favorably with predicted capabilities.

RCA VICTOR COMPANY, LTD. (CANADA)

5852 Research Report 6-400-4 (7-401-2) (ASD-TR-61-589), "The Radio Spectrum from 10 Gc to 300 Gc in Aerospace Communications. Vol. IV. Absorption in Planetary Atmospheres and Sources of Noise," A. Evans, M. P. Bachynski, and A. G. Wacker, AF 33(616)-7868, Aug 62, (174:110), Unclassified, AD 294 452.

This report includes a thorough review of present knowledge concerning resonant absorption in gases and the role it plays in the absorption of electromagnetic radiation in the atmospheres of both earth and the other planets. Both experimental and theoretical aspects are considered. The treatment includes a brief summary of absorption and scattering by rain and fog. Much data is included in tabular form.

RCA VICTOR COMPANY, LTD. (CANADA) (CONT.)

5853 Report 6-400-5 (7-401-3) (ASD-TR-61-589), "The Radio Spectrum from 10 Gc to 300 Gc in Aerospace Communications. Vol. V - Plasma Effects in Aerospace Communications," I. P. French and M. P. Bachynski, AF 33(616)-7868, Mar 62, (-:165), Unclassified, AD 282 610.

(BD-4272) The role of natural and artificial plasmas in aerospace communications is reviewed. The ionized shock wave of a re-entry vehicle is studied with special reference to the problem of propagation of rf energy through it. The properties of antennas operating in ionized regions are considered, together with the microwave radiation emitted by plasmas which appears as noise at a receiver. An attempt is made to evaluate the role of other natural and artificial plasmas such as the ionosphere, aurora, rocket exhaust, and nuclear blasts, on communication.

5854 Research Report 7-801-2 (CARDE Technical Memorandum AB-26), "Plasmas and the Electromagnetic Field," M. P. Bachynski, I. P. Shkarofsky, and T. W. Johnston, Jan 59, (150:66), Unclassified, AD 217 987.

A fundamental review of plasma physics with emphasis on interaction of electromagnetic waves with plasmas. The basic ideas of the motion of charged particles comprising a plasma gas are presented and followed by more rigorous formulations. Interactions of the atomic gas constituents are considered and their effects assessed under various conditions. Electromagnetic-wave interaction is introduced through Maxwell's equations for both uniform and non-uniform plasmas. Finally, microwave measurements and techniques for determining plasma properties, their utility and limitations are discussed.

5855 Research Report 7-801-11 (Scientific Report 1, AFCRL-378), "Transmission and Reflection of Electromagnetic Waves at a Plasma Boundary for Arbitrary Angles of Incidence," K. Graf and M. P. Bachynski, AF 19(604)-7291, Mar 61, (29:6), Unclassified, AD 260 305.

Interaction of a plane electromagnetic wave with a flat, freespace-plasma interface was studied for arbitrary angles of incidence. When a uniform, isotropic plasma is described by a complex dielectric coefficient, phase and attenuation constants for the waves in the plasma are functions of dielectric coefficient and incidence angle. The plasma can support independent horizontally and vertically polarized waves. Expressions and graphical representations show the amount of energy reflected and refracted at the interface as a function of incidence angle and plasma parameters. The vertically polarized case shows a maximum in the energy entering the plasma at the Brewster angle. The elliptical polarization of a plane wave reflected from the interface, when a wave with equal horizontally and vertically polarized components is incident on the interface, suggests the similarity of lossless plasmas to ordinary dielectrics, and of lossy plasmas to metals.

5856 Research Report 7-801-14 (Scientific Report 1, AFCRL-62-186), "Transmission and Reflection of Arbitrarily Polarized Electromagnetic Waves at the Boundary of an Anisotropic Plasma," K. A. Graf and M. P. Bachynski, AF 19(604)-7432, Jan 62, (120:18), Unclassified, AD 276 362.

The interaction of a plane electromagnetic wave with a flat, uniform, freespace-plasma interface in a static magnetic field is studied for arbitrary angles of incidence. The analysis is greatly simplified by writing the boundary conditions in terms of the fields in the plasma; for the model considered,

RCA VICTOR COMPANY, LTD. (CANADA) (CONT.)

5856 (Cont.)

a rigorous solution has been obtained, which indicates that two waves can be simultaneously supported by the plasma. These are, in general, elliptically polarized, plane, and nonhomogeneous; either can be launched by a suitable elliptically polarized, plane incident wave. "Backward waves" are found which appear to move upward toward the plasma interface while actually carrying energy into the plasma, and totally reflected waves which have both finite attenuation and finite phase coefficients in the plasma ("modified Sommerfeld" waves). Graphs of transmission coefficients and a computer program comprise most of the report.

5857 Report 7-801-24, "Microwave Scattering from Supersonic Plasma Flow-Fields," A. I. Carswell, Jan 63, (143:64), Unclassified, AD 401 383.

This report was prepared for RCA Missile and Surface Radar Division and was also issued by the latter in the DAMP series (see Abstract 5828).

5858 Research Report 7-801-26 (Scientific Report 2, AFCRL-63-161), "Microwave Measurements of Finite Plasmas," M. P. Bachynski, G. G. Cloutier, and K. A. Graf, AF 19(604)-7334, May 63, (181:24), Unclassified, AD 415 324.

A series of investigations designed to test the validity of various theoretical treatments of plasma properties, and to assess the accuracy of various microwave systems for determining the properties of finite plasmas using free-space microwave techniques. Theoretical results are obtained for predicting plasma effects such as: plasma boundaries, refractive defocusing, non-uniformity of plasma, and diffraction due to finite size of the plasma. Measurements on various experimental geometries demonstrate the influence of the dielectric boundaries of the plasma container, the effect of multiple reflections within the measurement system, and the precautions which must be exercised both in measuring and in interpreting the results. Measurements of plasma properties using a number of different microwave arrangements are evaluated and limitations of the various systems shown. Free-space microwave determination of the properties of a plasma generated in helium and in argon are presented.

REDSTONE SCIENTIFIC INFORMATION CENTER

5859 RSIC-245, "Experimental Methods for Measurement of Radar Backscattering Cross Sections," J. E. Terry, 10 Aug 64, (33:44), Unclassified, AD 462 080.

This document comprises a survey of several representative methods currently used for measuring backscatter cross-sections. The basic principles of each are briefly stated and any significant advantages or disadvantages noted. The techniques included are grouped under the following headings: standing-wave method, Doppler-shift method, magic-T method, space-separation method, time-separation method, FM-radar method, and outdoor methods. A bibliography of 44 items includes abstracts and a subject index.

ROME AIR DEVELOPMENT CENTER

5860 RADC-TR-58-53, "Properties of the Van Atta Reflector Array," D. Sharp, Apr 58, (18:3), Unclassified, AD 148 684.

ROME AIR DEVELOPMENT CENTER (CONT.)

5860 (Cont.)

A four-by-four Van Atta array of sixteen dipoles spaced at 0.6λ for 2650 Mc was constructed and tested. The wide-angle reflecting capability of this array was found to be equal to and better than that of a corner reflector, but the array is limited by the frequency band, polarization, and directivity of the radiators used. Polarization sensitivity can be overcome by using a crossed-dipole arrangement or circularly polarized radiators such as helices and flat spirals; the helix and spiral would also broaden bandwidth. Backscatter patterns for illumination frequencies of 2850, 3000, and 3200 Mc are included.

5861 RADC-TN-58-249, "Evaluation of Precipitation Effects on Radars Operating at Millimeter Wavelengths," J. Coyne, Sep 58, (24:13), Unclassified, AD 148 906.

Describes a study of precipitation backscattering and attenuation in the millimeter region. The equivalent target cross-section Γ of precipitation is expressed as $\Gamma = \eta V$, where Γ is the target cross-section, η is the reflectivity coefficient, and V is the pulse volume. The dependence of η on dielectric constant K, drop size, and intensity of the precipitation, and is given by

$$\eta = \frac{\pi^5}{\lambda^4} |K| Z \times 10^{-12} \quad ,$$

where Z is the reflectivity factor. Values of $|K|^2$ are tabulated for various temperatures and wavelengths. Experimental evidence has shown that $Z \cong 220 R^{1.6}$, where R is the rainfall rate in mm/hr.

Values of η for ice and snow are expressed in terms of equivalent rainfall rate. It is reported that for an equivalent rate, snow and ice have reflectivity coefficients approximately 0.22 times that of rain. One exception to this is the bright-band effect occurring in the melting zone, where reflection characteristics are from 1.6 to 6.3 times that of rain of an equivalent rate. It is pointed out that signal-to-noise ratio can be enhanced 18 dB during rain by use of circular polarization.

5862 RADC-TR-59-244A, "Proceedings of Second Annual RADC International RAM Symposium. 9, 10, 11 June 1959, Vol. 1," Dec 59, (105:-), Unclassified.

(BD-8209) Electromagnetic absorbing material design and techniques, in both the U. S. and Europe, are discussed. Papers include: "Scattering from An Absorber-Coated Conducting Cylinder," J. Vaccaro; "The Bandwidth of A Single Layer Absorbing Material," B. W. Sherman and D. L. Waidelich; "Radar Absorption by Periodic Sheets," W. Franz; "Experimental Investigations on Absorbers for Electromagnetic CM-Waves in Göttingen," E. Meyer; "Surface Waves in Ferrite Structures," A. A. vanTrier; "Fast Modulation on Waveguide by Means of Ferrites," J. Robieux; "Simple Types of Wave Functions in Radar Transmission and Absorption," W. Braunbek; "Plasma Theory and Thermodynamics of Irreversible Processes," J. Meixner; "Interaction Between Millimeter Waves and Ionized Oxygen," P. Marie; "The Ionosphere As An Absorbing Plasma," H. Bremmer; and "Broadband Nonmagnetic Microwave Absorbers," G. Latmiral.

ROME AIR DEVELOPMENT CENTER (CONT.)

5863 RADC-TDR-64-25, Vol. I, "Radar Reflectivity Measurements Symposium, Volume I," Apr 64, (548:-), Unclassified, AD 601 364.

This document is Volume I of the proceedings of a symposium held at Lincoln Laboratory on 2-4 June 1964. It contains papers on the following broad subject areas: reflectivity measurements--past, present, future; reflectivity ranges, their geometry and techniques for their use; special equipment for reflectivity ranges; and models, model supports, special materials. With the exception of two that were not pertinent, the individual papers are separately abstracted below. For Volume II, see Abstract 5908.

5864 Paper in Abstract 5863. "Some Notes on the History of Radar Reflectivity Measurements Using Models," G. Sinclair (University of Toronto), (1:-), Unclassified.

(Only an abstract of this paper is included.) Model measurements of radar reflectivity since World War II are reviewed.

5865 Paper in Abstract 5863. "Methods of Measuring Scattered Fields (A Historical Survey of the Development at Harvard University)," K. Iizuka (Harvard University), (17:49), Unclassified.

Six experimental techniques for measuring backscatter cross-sections and the diffracted field are described briefly. They are: standing-wave-ratio, cancellation, partial reflection, Doppler shift, pulse, and application of scattering technique to field measurements (two versions of probes). A block diagram of the experimental set-up and sample results are included for each method, and references given to original reports or articles.

5866 Paper in Abstract 5863. "Future Trends in Radar Cross Section Measurement," K. M. Siegel (Conductron Corp.), (1:-), Unclassified.

(Only an abstract is included.) It is suggested that near-field measurements will be used to predict far-field cross-sections, and that short-pulse observations will be used to predict long-pulse answers.

5867 Paper in Abstract 5863. "Comments on Static Radar Reflectivity Measurements Techniques," W. F. Bahret (AF Avionics Lab., Wright-Patterson AFB), (11:0), Unclassified.

Description of static radar-reflectivity measurement techniques investigated at the Air Force Avionics Laboratory, using CW and short-pulse X-band radars with absorber-lined, "twin-tunnel" antennas. Crosstalk levels of 100 and 118 dB were repeatedly obtained for the CW and short-pulse radars, respectively. Received background signal level was approximately 15 dB below that from a 4×10^{-5} m^2 sphere at a range of 25 ft from the antennas. Anechoic chamber design and the fabrication of scale models are discussed, and it is pointed out that for full-scale bodies with σ over 0.1 m^2, all important contributors to cross-section should be included in the model.

5868 Paper in Abstract 5863. "Radar Cross Section Model Measurements," W. E. Blore, R. I. Primich, R. A. Hayami, et al. (General Motors, Defense Research Labs.), (11:18), Unclassified.

ROME AIR DEVELOPMENT CENTER (CONT.)

5868 (Cont.)

This paper summarizes GM's past ten years' activities of operating four model-measurement radars in an anechoic chamber. Three CW balanced-bridge radars operating at frequencies of 10, 35, and 70 Gc and one short-pulse radar operating at 35 Gc were used. These radars have been used to investigate effects of non-plane-wave illumination, various model support methods, cancellation techniques, model dimensions and finishes, transmitter frequency stability, and data recording techniques. A hypersonic ballistics range is discussed in which CW radars are used to measure nose-on and wake echoes of models.

5869 Paper in Abstract 5863. "State-of-the-Art Anechoic Backscatter Ranges," W. H. Emerson and F. P. Brownell (B. F. Goodrich Co.), (15:5), Unclassified.

Description of the state-of-the-art in backscatter chambers at B. F. Goodrich, including comparative information on three anechoic chambers designed and installed by the company at Martin, Sperry, and AIL. The relative merits of inherent radar cross-section and backwall reflection coefficient for defining chamber performance are discussed. An equation for converting a known equivalent chamber cross-section σ_1 for a reference-target distance R_{t1} and radar-to-backwall distance R_{w1}, to the equivalent chamber cross-section σ_2 for R_{t2} and R_{w2} equivalent target and backwall distances is:

$$\sigma_2 = \sigma_1 + 10 \log \left(\frac{R_{t1}}{R_{t2}}\right)^4 \left(\frac{R_{w2}}{R_{w1}}\right)^2 \ (\text{dB} < \text{m}^2).$$

It is pointed out that the major improvements have been in backwall absorbing materials and an arrangement for tilting the backwall.

5870 Paper in Abstract 5863. "Transmission Line Scattering Range," M. J. Gans (MB Associates), (10:8), Unclassified.

Description of a transmission-line scattering range which has the advantage that $1/R^4$ attenuation is eliminated, thus achieving much greater sensitivity than a conventional range. Cross-sections of 1/8", 3/16", and 1/4" spheres were measured at 8.75 Gc and found in very close agreement with theory.

5871 Paper in Abstract 5863. "An Effect of Wall Illumination upon Microwave Anechoic Chamber Performance," R. J. Garbacz and J. L. George (Antenna Lab., Ohio State University), (16:2), Unclassified.

Discussion of perturbation in background level due to target-wall interaction. The analysis considers both scattering from wall to target to receiver, and scattering from target to wall to receiver. Although brief experiments indicate that target-wall interaction can be a source of error for large targets of low cross-section and for small targets of large cross-section, it is concluded that other system errors are probably more important.

5872 Paper in Abstract 5863. "Complete Radar Cross-Section Measurements," J. R. Huynen (Lockheed Missiles and Space Co.), (17:16), Unclassified.

ROME AIR DEVELOPMENT CENTER (CONT.)

5872 (Cont.)

The concept of a complete set of radar cross-section data is introduced, by which is meant sufficient data to define the cross-section at all aspects. If the target scattering matrix is known, a complete set at all linear polarizations can be determined. Five aspect-dependent target parameters completely describe the scattering matrix for any target at a single frequency. The parameters are: (1) orientation angle of maximum polarization; (2) ellipticity angle of maximum polarization; (3) phase of maximum polarization; (4) intrinsic target parameter related to local surface curvature; and (5) maximum receivable cross-section of the target.

5873 Paper in Abstract 5863. "Use of Radar Cross Section Data in Military Systems Analysis," H. A. Ecker (Systems Eng. Group, Wright-Patterson AFB), (12:6), Unclassified.

A general discussion concerning radar-reflectivity measurements, with emphasis on the way in which RCS data is used in military systems analysis. Description is included of the basic approach followed by the Synthesis and Analysis Division for using cross-section data and calculating the effect of cross-section on survival probability. This model incorporates such parameters as the characteristics of the radar, the target cross-section, and ECM.

Airborne detection of ground targets is discussed briefly. It is pointed out that there is a serious inadequacy of cross-section data for analysis applications. Data is lacking for many types of targets and backgrounds. In most instances where data is available, it applies only for a restricted frequency range. Although much experimentation has been done using various radar polarizations, data is still lacking on the effect of polarization on the cross-sections of ground targets and clutter sources.

5874 Paper in Abstract 5863. "A Comparison Between Longitudinal Baffling and Transverse Fence for Reducing Range Ground Scattering," A. F. Kay, (17:2), Unclassified.

The longitudinal baffle and the transverse fence are often used to suppress ground reflections in antenna and backscatter ranges. Equations are given for calculating reflected ground signal relative to the direct signal when a longitudinal baffle or transverse fence is placed between the antennas. The best theoretical reduction in ground signal for an optimally placed baffle is 14.5 dB. An experimental system operating at 38.8 Gc verified some of the theoretical data for scale-model studies. It was concluded that an optimal fence arrangement is superior to the best baffle arrangement.

5875 Paper in Abstract 5863. "An Analysis of Reflection Measuring Systems," R. G. Kouyoumjian (Antenna Lab., Ohio State University), (19:16), Unclassified.

This paper is essentially a condensation of an earlier report; see Abstract 2458.

5876 Paper in Abstract 5863. "Measuring the Phase and the Amplitude of Backscattered Radar Energy on a Static Range," N. R. Landry (RCA Missile and Surface Radar Division), (18:4), Unclassified.

ROME AIR DEVELOPMENT CENTER (CONT.)

5876 (Cont.)

Brief discussion of a pulse system capable of measuring phase to ±5° rms for a 0.01-m^2 target and amplitude to ±1 dB at 1300 Mc. Some of the stability problems associated with a full-scale pulsed system are explored, with special emphasis on the effects of range background on phase measurements. Phase variations due both to target-aspect change and to range change (time delay) are considered. It is concluded that the system is capable of measuring phase variations of the target echo regardless of their cause.

5877 Paper in Abstract 5863. "Surface Currents in Thin Conducting Sheets," P. Magoulas and P. A. Matthews (University College, London), (28:5), Unclassified.

Current distributions on various thin sheets suspended in electromagnetic fields were measured and used to calculate the effective backscatter cross-sections. The indoor system operated at 3000 Mc with 3-kc modulation; a bridge-detection scheme was used to measure amplitude and phase. Theoretical equations are developed for calculating front-edge current and backscattering from the front edge, assuming the current can be regarded as a current filament along the plane of incidence. Plots of theoretical and measured values for amplitude and phase of the current show them to be in fair agreement. Theoretical backscattering from the front edge is compared to measured backscattering from a thin wire. Surface waves on elliptical cylinders and rectangular sheets were also investigated. It was concluded that currents on rectangular sheets can be measured in two parts: front-edge currents, and currents due to traveling waves on the sheet. The measured values of the currents can be used to calculate the effective backscattering cross-section.

5878 Paper in Abstract 5863. "CW Measurements of an Echo II Balloon in the Near Zone," R. K. Ritt and A. W. Wren, Jr. (Conductron Corp.), (13:2), Unclassified.

Description of procedures used for CW measurements of an Echo II balloon in the near zone, including calibration and test sequences. All measurement equipment was located 100 ft from the center of the balloon, whose radius was 67.5 ft. A scaffold arrangement supported transmitting and receiving antennas capable of horizontal or vertical polarization in such a way that ±15° aspect angles were obtainable. Tests were performed at frequencies of 1.71, 5.65, and 5.85 Gc. It was determined analytically that the measured near-field cross-section of the balloon should be increased by 4.5 dB in order to obtain the true cross-section. Also discussed are bistatic scattering for plane-wave and spherical-wave incidence.

5879 Paper in Abstract 5863. "Application of Surface Field Measurements to Radar Cross Section Studies," T. B. A. Senior (Radiation Lab., University of Michigan), (11:16), Unclassified.

The measurement of surface fields on scatterers was investigated to learn more about the relation between surface fields and far-zone scattered fields. Measurements of current distributions using probes have proved valuable in improving theoretical tools for predicting scattering patterns. The measurements were performed at L- and S-bands using several types of probes, of which a simple shielded loop proved the most satisfactory. A variety of target models were measured, including thin wires, flat plates, thin cylinders, spheres, and cone-spheres. Typical results are presented in graphic form.

ROME AIR DEVELOPMENT CENTER (CONT.)

5880 Paper in Abstract 5863. "The Terrain Scattering Problem," R. C. Taylor (Antenna Lab., Ohio State University), (10:5), Unclassified.

Studies have shown that terrain backscattering is affected by five parameters: surface roughness, polarization, complex dielectric constant, incidence angle, and frequency. From this work, requirements in system design and techniques are deduced which must be satisfied in order to measure σ° accurately. A mobile CW Doppler radar system capable of operating at 10, 15, and 35 Gc is described (including block diagram); with the addition of a receiving antenna, it was converted to a bistatic X-band system. Sample data from tests made with these two systems are graphed.

5881 Paper in Abstract 5863. "Studies in Radar Cross Section Measurements," P. H. Ware (Douglas Aircraft Co.), (7:0), Unclassified.

Description of a measurement procedure called "traversing" for reducing the effects of backwall scattering and transmitter-receiver crosstalk so that theoretically minimum targets are detectable. The procedure was investigated at X-band in an anechoic chamber, using an electrically and mechanically stable CW system to measure cross-sections of spheres of various diameters.

5882 Paper in Abstract 5863. "Precision Measurement of the Radar Scattering Matrix," J. A. Webb and W. P. Allen (Lockheed-Georgia Co.), (13:4), Unclassified.

Description of CW X-band equipment for measuring radar cross-sections in an anechoic chamber. The system is quasi-monostatic, and unique in that electromechanical servo mechanisms drive a precision microwave phase shifter and a precision attenuator such that the receiver output is maintained at a null. Measurements were made of returns from long thin wires of various lengths. Mean cross-section values averaged over 180° azimuth angle and 180° polarization angle are plotted vs. wire length. Good correlation was obtained with theoretical values and results of other investigators.

5883 Paper in Abstract 5863. "Very Small Radar Cross-Section Measurements at UHF," P. J. Willcox (Goodyear Aerospace Corp.), (11:3), Unclassified.

A quasi-Doppler technique was used successfully to measure radar cross-sections accurately on the order 10^{-5} λ^{2} in the UHF band. This technique greatly extends the accuracy of measurements at frequencies as low as UHF, where background levels are generally higher. In this method, the target is moved slowly in the direction of propagation and the output recorded. The output will vary through a full period for each half wavelength of target motion. Assuming background level remains fixed in amplitude and phase, the variation superimposed on the output is the error due to background as a function of target position.

5884 Paper in Abstract 5863. "Indoor Range Design," R. J. Wohlers (Cornell Aeronautical Lab.), (30:0), Unclassified.

A successful radar cross-section measurement range requires excellent electronic circuitry and mechanical instrumentation, and careful reduction of unwanted reflections from the surrounding environment; the latter is the most important of the three factors. This paper deals with the design principles involved in reducing undesired signal returns from the physical environment, particularly in indoor facilities. Curves relate effective backscatter reflection coefficients of microwave absorbers to the angle off normal. Several CW and pulse ranges are analyzed mathematically.

ROME AIR DEVELOPMENT CENTER (CONT.)

5885 Paper in Abstract 5863. "An Analysis of the Polarization Capabilities of a Ground Plane Cross Section Range," A. W. Wren, Jr., J. A. Green, and C. M. McDowell (Conductron Corp.), (13:2), Unclassified.

This paper reports on the theoretical aspects of work covered in a report; see Abstract 5303.

5886 Paper in Abstract 5863. "Pulsed Backscatter Range Instrumentation," A. J. Cann (Advanced Development Lab., Inc.), (11:6), Unclassified.

Description of design techniques for two operating pulsed-radar systems used for backscatter range measurements. The range-gating capability enables a pulsed radar to discriminate against background and feed-through signals better than can a CW system. In addition, a pulsed system enables the fine structure of target signatures to be examined. The short maximum range and low data-rate usually required enable many pulses to be integrated for each data point, thus furnishing high sensitivity with low transmitted power.

5887 Paper in Abstract 5863. "The Hughes Back Scatter Measurement Radar and Recording Equipment," J. D. Carlson (Hughes Aircraft Co.), (11:0), Unclassified.

This well-written paper describes in detail some of the problems encountered during instrumentation and operation of a short-pulse, backscatter measurement range and the solutions thereto. Emphasis is placed on problems common to short-pulse systems in general, and on signal-processing and data-recording techniques. Briefly discussed are low-noise wide-band rf amplifiers, wide-band rf-to-video detectors, oscilloscope display of low-voltage nanosecond video pulses, and data-recording techniques for nanosecond video pulses.

5888 Paper in Abstract 5863. "A Method of Phase Measurement for Pulsed Radar Systems," B. Falk (General Dynamics/Fort Worth), (7:0), Unclassified.

Description of a phase-measuring technique in which feedback principles are employed. A feedback loop around the entire i-f system is used to eliminate the errors and nonlinearities that would result from simple phase detection of the i-f output. A block diagram of the system used is given, along with several amplitude and phase plots of typical radar targets. Application of the equipment to direct measurement of scattering matrix and background subtraction is briefly discussed.

5889 Paper in Abstract 5863. "RF Phase Stability Requirements for Balanced CW Reflectometers," W. D. Fortner (Micronetics Inc.), (14:1), Unclassified.

Assuming an idealized equivalent circuit for a balanced CW range, the analysis presented indicates that the background cancellation capability of a balanced CW measurement range depends critically on the transmitter's frequency stability as well as on the mechanical stability of both microwave circuitry and environment. The analysis suggests some expedients for optimizing the performance of balanced-bridge systems.

5890 Paper in Abstract 5863. "Nanosecond Pulse Scattering Systems," R. R. Hively (Micronetics Inc.), (5:2), Unclassified.

ROME AIR DEVELOPMENT CENTER (CONT.)

5890 (Cont.)

Description of the pulsed radar scattering systems in use at Micronetics. The system transmitters are categorized as long-pulse (200 to 250 nsec), intermediate-pulse (10 nsec), and short-pulse (0.4 to 0.7 nsec). All system receivers are variations of one basic unit, depending upon frequency. Gating of receivers and data-handling are described, along with low-cross-section styrofoam and nylon-cord model mounts. For long-pulse operation, system frequencies available are L-, C-, X-, K_u-, and K_a-bands; for intermediate-pulse, X-band; and, for short-pulse, frequencies are L- and X-bands.

5891 Paper in Abstract 5863. "The Automatic Recording of Effective Radar Cross Section," C. W. Matthis, Jr. (Boeing, Wichita), (7:4), Unclassified.

Description of a plotter that records simultaneously both instantaneous and average values of radar cross-section of targets. This "average" value is proportional to the integral of $\sqrt{\sigma}$ as a function of aspect angle. Equipment capabilities include plotting cross-sections over a 40-dB amplitude range vs. aspect-angle increments of 2°, 5°, and 10°. Sample data recorded from an aircraft model by the average plotter are compared with median data obtained manually from the instantaneous plot of the same target model.

5892 Paper in Abstract 5863. "A Method of Static Radar Cross Section Measurement for Pulsed Radar Systems," J. M. Murchison (General Dynamics, Fort Worth), (10:0), Unclassified.

Description of a receiver for cross-section measurements incorporating a closed-loop servo system which compares a reference signal with the target signal and automatically adjusts it to an equal amplitude with a servo-driven i-f attenuator. The attenuator dial reading and shaft position are proportional to σ for the target. The method also offers a considerable improvement in sensitivity and stability over conventional antenna-pattern measurement techniques.

5893 Paper in Abstract 5863. "Polarization Aspects of Radar Reflectivity Measurements," R. D. Tompkins (Naval Research Lab.), (10:13), Unclassified.

The concept of the scattering matrix is reviewed, and measurement techniques and components are treated. It is emphasized that control of the illuminating polarization is required; the basic component for controlling polarization is the two-port circularly polarized antenna. The use of a polarization simulator for studying polarization phenomena is mentioned briefly. It is concluded that there is difficulty in stating which polarization parameters and measurement techniques have the most potential.

5894 Paper in Abstract 5863. "Reflecting Properties of Aircraft Materials at 0.6943 and 1.06 Microns Using Pulsed Lasers," S. E. Barber (Naval Ordnance Test Station), (7:0), Unclassified.

The reflectivity of three samples of aircraft paints (light and dark grey, and fluorescent orange) was measured for laser light at wavelengths of 0.6943 and 1.06 microns. The results are presented as signal strength vs. detector angle. Techniques employed for optical model cross-section measurements are briefly described.

ROME AIR DEVELOPMENT CENTER (CONT.)

5895 Paper in Abstract 5863. "Microwave Back-Scattering from Supersonic Laboratory Plasma Streams," A. I. Carswell and M. P. Bachynski (RCA Victor Company, Ltd.), (18:20), Unclassified.

The signal backscattered from supersonic plasma streams in argon was measured as a function of aspect at 10 and 25 Gc, and compared with backscatter from dielectric and metal rods of the same geometry. The scattering depends critically on the ratio of plasma frequency to incident frequency, on aspect angle, on polarization (for columns of small diameter compared to λ), and on the nature of the flow itself. For laminar flowing plasmas, scattering characteristics similar to dielectric rods were obtained and only slight fluctuation of the scattering amplitude occurred. For turbulent plasma, observed signal variations due to turbulence were larger than the aspect variations.

5896 Paper in Abstract 5863. "The Spin-Drop Method of Measuring Model Radar Cross Section," P. C. Fritsch (Lincoln Lab., MIT), (10:0), Unclassified.

Description of a method for making indoor radar cross-section measurements without the use of target model-support structures. For the technique, called "Spin Drop," a spinning target model is dropped from above and allowed to fall perpendicularly through the beam of a CW K_a-band radar; the target's rotational speed is 2000 rpm which allows one complete revolution per beamwidth (about 1 ft). Models up to 8 inches in length and several pounds in weight were tested. The plane of rotation of the targets is held to within 1° of horizontal throughout the drop.

5897 Paper in Abstract 5863. "A Method of Measuring Small Radar Cross Sections by Digital Vector-Field Subtraction," F. E. Heart and P. C. Fritsch (Lincoln Lab., MIT), (5:0), Unclassified.

The investigation indicates that, if coupling between the target and its supports is negligible, the interference contributions of the supports can be substantially reduced by the vector-field subtraction technique. A K_a-band CW radar was employed, and preliminary results indicated that target cross-sections as much as 10 to 20 dB less than the support cross-section can be measured. Sample data obtained from a model-support column made of styrofoam and a cone-sphere target are included. It was concluded that this technique would prove even more useful at lower frequencies; a pulsed system would also give improvement.

5898 Paper in Abstract 5863. "Radar Cross-Section Model Fabrication at Cornell Aeronautical Laboratory," J. E. Hopkins (Cornell Aeronautical Lab.), (4:0), Unclassified.

Problems and techniques of making models for use at X- and K_a-bands are discussed. The need is noted for lightweight models to permit the use of supports with small radar reflectivity. The merits of wooden models and precautions which must be taken in working with them are mentioned.

5899 Paper in Abstract 5863. "Metal-Sprayed Fiberglas Radar Target Models," F. M. Hudson (Hughes Aircraft Co.), (7:0), Unclassified.

ROME AIR DEVELOPMENT CENTER (CONT.)

5899 (Cont.)

Brief description of the flame metal-spraying process as a means of applying metallic surfaces to such nonmetals as glass, paper, and plastics. When a spraying technique with optimum heating is used, a 3-mil-thick aluminum film exhibits a conductivity 80% to 90% of that of the basic metal. Radar cross-section measurements revealed that the measured σ of a metal-sprayed sphere 2 ft in diameter was within ±1 dB of the theoretical.

5900 Paper in Abstract 5863. "Antenna Scattering Measurements," D. L. Moffatt (Antenna Lab., Ohio State University), (14:11), Unclassified.

The contents of this paper are covered in a report by the same author, see Abstract 5751.

5901 Paper in Abstract 5863. "The Effect of Finite Conductivity on Radar Cross Sections," L. Peters, Jr. (Antenna Lab., Ohio State University), (16:16), Unclassified.

Analysis of the relation between radar cross-sections of metallic bodies and those of similar bodies having finite conductivity. For a lossless body with a shape such that its cross-section arises largely from a specular reflection and a creeping wave, a first approximation can be obtained by multiplying σ for the metallic body by the square of the Fresnel reflection coefficient. For a dielectric body with small conductivity (lossy), the modified geometrical-optics method yields approximate cross-section. The case of a long thin body of finite conductivity is also considered, where the body is treated as a long thin antenna excited in the principal mode.

5902 Paper in Abstract 5863. "Dielectric Properties; Data and Measurement Techniques," P. E. Rowe, E. J. Luoma, and E. F. Buckley (Emerson & Cuming, Inc.), (19:5), Unclassified.

Properties of some commercially available dielectric materials are listed, and recent advances in the techniques of measuring these properties and reducing resultant data are summarized. Low-loss and lossy dielectric materials are distinguished, and various materials of both types tabulated according to dielectric constant and loss tangent as a function of frequency. Techniques for using the dielectrometer and interferometer to measure microwave dielectric properties are discussed.

5903 Paper in Abstract 5863. "Nanosecond Pulse Scattering from Extended Laboratory Targets," H. S. Rothman, H. Guthart, and T. Morita (Stanford Research Institute), (28:10), Unclassified.

An X-band (9.4 Gc) radar with a pulsewidth of 1 nanosecond was used to study pulse-broadening and interference effects in the reflected signal from targets of simple configuration, such as an array of dipoles and a metal cylinder. Backscatter from an extended laminar-plasma column was also measured, and the results compared with calculations based on a homogeneous model approximation.

5904 Paper in Abstract 5863. "Surface Roughness and Tolerances in Model Scattering Experiments," T. B. A. Senior (Radiation Lab., University of Michigan), (18:11), Unclassified.

ROME AIR DEVELOPMENT CENTER (CONT.)

5904 (Cont.)

Theoretical and experimental studies of scattering from models as a function of surface roughness and tolerances indicate that a high degree of surface finish is not essential. Although the investigation was limited to specific shapes (spheres, cones, cone-spheres) and roughnesses, the conclusions should have general application. Imperfections of 10^{-3} λ were found to affect the dominant features of a backscattered pattern by only a small fraction of a dB, and the deep minima by no more than a dB or so; a similar criterion for overall tolerances should be more than adequate. Curves and tables relate cross-sections to surface roughness as functions of target shape, surface roughness, polarization, and frequency (X-, S-, and K-bands).

5905 Paper in Abstract 5863. "Estimates of the 'Volume' Return from Styrofoam," T. B. A. Senior and E. F. Knott (Radiation Lab., University of Michigan), (6:1), Unclassified.

Brief description of an experiment to measure the volume return backscattered from styrofoam and relate it to calculated value. Typical data are given in the form of cross-section vs. frequency (8.5 to 9.9 Gc). From the measured data, the volume return was estimated to be 1.6×10^{-4} m^2 per m^3, as compared to a calculated value of 7.4×10^{-5} m^2 per m^3.

5906 Paper in Abstract 5863. "The Near Field of a Styrofoam Cylinder," T. B. A. Senior and E. F. Knott (Radiation Lab., University of Michigan), (15:0), Unclassified.

An investigation to explain an unusual scattering effect observed when a sphere was mounted in a slight depression on a long horizontally oriented styrofoam column. The nature of the effect is depicted in a curve showing measured radar cross-section as a function of the rotational angle of the entire assembly in the horizontal plane. Excluding a ±20° sector about the aspect angle (180°) at which the sphere was farthest from the transmitter, the measured cross-section is almost independent of aspect angle θ and within 1 dB of that appropriate for the sphere alone. However, as θ increases beyond 160°, the net return begins to oscillate with a period of approximately 7° about a level which falls rapidly at 180° to a minimum of some 16 dB below the free-space return from the sphere. Although study of the phenomenon was not complete, it was concluded that surface waves on the cylinder were perturbing the results, and that the partial immersion of the target in the styrofoam might also influence the measurement by perturbing surface waves on the target sphere.

5907 Paper in Abstract 5863. "Modeling of RAM-Covered Complex Bodies," A. S. Thomas (A. S. Thomas, Inc.), (7:3), Unclassified.

Feasibility analysis of making scale models with lossy materials if the complex permeability and permittivity of materials on full-scale models cannot be satisfactorily reproduced at higher model frequencies. Provision would have to be made for obtaining magnetic materials having approximately the same loss tangent at model and full-scale frequencies and adjusting dielectric loading to satisfy the scaling criteria. Discussion is limited to the case of normal incidence; however, oblique incidence may be handled by showing that scaled parameters satisfy the scattering coefficients and hence the scattered field.

ROME AIR DEVELOPMENT CENTER (CONT.)

5908 RADC-TDR-64-25, Vol. II, "Radar Reflectivity Measurements Symposium, Volume II," Apr 64, (372:-), Unclassified, AD 601 365.

This volume of the symposium proceedings contains 44 papers on the following broad subject areas: calibration and range intercalibration; measurement procedures and measurements data standards; measurement correlation and application; and range descriptions. Individual papers are described in separate abstracts below. For Volume I, see Abstract 5863.

5909 Paper in Abstract 5908. "Radar Cross-Section Data Generation and Recording in the Cornell Aeronautical Laboratory Ranges," R. V. Gallagher (Cornell Aeronautical Lab.), (4:0), Unclassified.

Description of data recording and handling techniques used with four cross-section measurement ranges at Cornell; the ranges used a pulse K_a-band radar, a CW K_a-band radar, a CW X-band radar, and a high-resolution, X-band, FM/CW radar. The brief description given for each range includes arrangement, type, and capabilities of the data-handling equipment.

5910 Paper in Abstract 5908. "Analytical Investigation of Near-Zone/Far-Zone Criteria," L. R. Hendrick (Cornell Aeronautical Lab.), (15:2), Unclassified.

The substance of this paper is contained in a report (see Abstract 5208).

5911 Paper in Abstract 5908. "Some Factors Affecting the Accuracy of Ground-Plane Measurements," J. C. Huber, Jr. and G. M. Hazlip (Goodyear Aerospace Corp.), (13:4), Unclassified.

An analytical and experimental investigation of factors affecting the accuracy of ground-plane cross-section measurements. Three factors are emphasized: the effects of amplitude and phase deviations of the rf field at both target and receiver; the effect of the target on background return; and accurate use of a reference sphere and the associated problem of coupling between sphere (or target) and the ground or other objects in the range. It was concluded that these factors do enter into measured data errors (significant fraction of a dB), and that care should be taken so that measurement accuracy is commensurate with dimensional accuracy of the target and with the intended use of the data.

5912 Paper in Abstract 5908. "Radar Reflectivity Measurement Data Format Standards," S. L. Johnston (U. S. Army Missile Command, Redstone Arsenal), (6:0), Unclassified.

Organizations concerned with radar-reflectivity measurements were surveyed to determine whether a standard data format was in use. It was concluded that while some data types are prevalent, there are no universally used standard formats. Advantages of a standard format are discussed.

5913 Paper in Abstract 5908. "Radar Measurement Standardizations Needed for Simulation Studies," C. Krichbaum (Battelle Memorial Institute), (11:2), Unclassified.

ROME AIR DEVELOPMENT CENTER (CONT.)

5913 (Cont.)

Much current range measurement data is inadequate for use in synthesizing the radar signatures of missiles. In general, a radar-signature calculation must account for radar frequency, aspect angle, roll angle, transmitting and receiving antenna polarizations, and possible dielectric coating of the target. The effect of measurement error upon calculation of cross-section histories using static data is analyzed.

5914 Paper in Abstract 5908. "A New Minimum Range Criterion for Measurement of Radar Cross Sections," L. Peters, Jr. (Antenna Lab., Ohio State University), (12:8), Unclassified.

Explanation of a new effective-minimum-range criterion, a modification of the often-used criterion $R_{min} = 2D^2/\lambda$ (where D is target dimension), which is applicable for point sources. It is shown that the also common modification $R_{min} = 2(D + d)^2/\lambda$ (where d = aperture) is invalid, since it ignores the constraints on the direction of energy flow. The new minimum-range criterion is $R_{min} = (2D^2 - d^2)/\lambda$; it is derived using ray optics.

5915 Paper in Abstract 5908. "Experience with Calibration Targets and Techniques at RCA-ERL," R. Sigler (RCA Missile and Surface Radar Division), (5:3), Unclassified.

Advantages, disadvantages and application of several reference calibration targets for C-band outdoor full-scale ranges are summarized. It is concluded that the sphere is best suited for use as a reference calibration target, primarily due to size, symmetry, and simplicity of measurement.

5916 Paper in Abstract 5908. "Comparison of Radar Cross Section Signatures," D. R. Brown and A. L. Maffett (Conductron Corp.), (15:0), Unclassified.

The theory of redistributed functions is developed and then adapted to radar cross-section data as a means of comparing RCS patterns. The discussion is mostly analytical and theoretical, but includes a section on the comparison of cross-section signatures for static and dynamic conditions. Representative graphical data for the static case is operated on and presented as static and dynamic quantile functions; these show the predicted distribution of RCS values for the dynamic case to be essentially the same as the static distribution when taken over the same aspect interval. It is concluded that redistributed functions are useful for obtaining from a cross-section signature almost any attribute of an "average" nature, and that this property of redistributed functions renders them useful as tools with which to compare signatures.

5917 Paper in Abstract 5908. "Contour Charts for Radar Cross-Section Analyses," D. Levine (Lockheed Missiles and Space Co.), (24:10), Unclassified.

Several forms of contour charts are examined as forms of presenting and reducing cross-section data as a function of aspect. The best configuration for the coordinate grid on which data are plotted depends upon symmetries in the shape of the test model. An illustration is given of the type of body best suited for each cartographic projection described. A sample cross-section pattern obtained from a 30° half-angle cone is presented as σ vs. aspect angle,

5917 (Cont.)

along with a Mercator sinusoidal projection of the same target. The additional information provided by RCS data in the latter form is readily apparent.

5918 Paper in Abstract 5908. "Target Recognition and Discrimination," R. F. Goodrich, O. Ruehr, Z. Akcasu, and G. Rabson (Radiation Lab., University of Michigan), (26:0), Unclassified.

An analytical discussion of a technique of radar target recognition and discrimination. The technique assumes that various classes of targets frequency-modulate impinging radar signals in characteristic ways that can be recognized and distinguished by processing the returned signals in filter banks. The type of filter used is termed a "mixed" filter; its parameters vary from that of an inverse filter to that of a matched filter. The inverse filter is best for range discrimination, while the matched filter is best for noise suppression. To demonstrate this filter scheme, a means of experimentation using a digital computer was derived. The results of the experiment are presented with several computed spectra of returned signals.

5919 Paper in Abstract 5908. "Sub-Nanosecond Pulse Methods of Radar Cross Section Measurement," R. R. Hively (Micronetics Inc.), (10:15), Unclassified.

Discussion on the use of sub-nanosecond pulses in cross-section measurement, including a brief history of the development and projected use of the technique. Sub-nanosecond pulses have been successfully generated at L-, S-, C-, X-, and K_u-bands, and X-band pulses have been amplified to more than 0.5Mw of peak power. Two sources of sub-nanosecond pulses are described: TR tube spike leakage, and short video pulsing at rf input to a travelling-wave tube. The latter method has produced pulses as short as 0.4 nsec. Sub-nanosecond pulses make it possible to determine what portions of a model target contribute to the RCS of the model and by how much.

5920 Paper in Abstract 5908. "Geometry and Instrumentation Considerations for Dynamic Reflectivity Measurements," E. G. Meyer and C. L. Mohre (Radiation Inc.), (13:0), Unclassified.

For dynamic RCS measurements, precise information required about the position and attitude of the airframe relative to the illuminating radar can be defined by six parameters: heading, roll, pitch, altitude, range, and azimuth. System considerations such as aircraft instrumentation, data-sampling rates, altitude monitoring, ground instrumentation, radar antenna system, and measurement receiver are discussed. An appendix describes the problem mathematically.

5921 Paper in Abstract 5908. "A Multi-Band, Polarization Diversity System for Dynamic Radar Cross-Section Studies," I. D. Olin and F. D. Queen (Naval Research Lab.), (11:5), Unclassified.

Description of a high-power pulsed radar system specially designed for measuring the cross-sections of full-size targets under dynamic conditions. The system permits simultaneous measurement and recording at L-, S-, and X-bands. Either vertical or horizontal polarization is possible for transmission at L- and S-bands, while X-band transmitted polarization may be vertical, horizontal, right-circular, or left-circular; all four components are received simultaneously. To permit optical tracking, the system range interval is

ROME AIR DEVELOPMENT CENTER (CONT.)

5921 (Cont.)

limited to a distance of 2000 to 20,000 yards. The prf is 500, the pulsewidth 1 μsec, and the nominal radiated power 250 kw. Sample data are given for a radar bouy and a twin-engine transport aircraft near broadside.

5922 Paper in Abstract 5908. "A New Method of Correlation of Down-Range Radar Measurements with Static Radar Cross Section Measurements," N. E. Pedersen, H. I. Halsey, J. F. Torrey, and J. B. Clemente (Avco/RAD), (10:0), Unclassified.

Demonstration of methods devised to correlate the dynamics of a nosecone during midcourse and early re-entry with its static radar cross-section pattern. Strong emphasis is placed on statistical methods; high-speed computer techniques provide information rapidly and in an easily interpreted format. The procedures require knowledge of radar cross-section as a function of aspect and polarization angles, the various aerodynamic coefficients and dynamic constant of the vehicle, the statistics of the various thrust mechanisms, and the location and polarization of the illuminating radar. Apparatus and experimental and computational methods are briefly described, including an elementary flow diagram of the computation technique.

5923 Paper in Abstract 5908. "Instrumentation of a Tracking Radar for Direct Recording of Radar Cross Section," D. C. Watson (General Dynamics/Fort Worth), (10:0), Unclassified.

A technique is described for enabling real-time dynamic cross-sections to be measured by adding an attachment to a tracking radar. A stable reference pulse is injected at rf and compared on a pulse-to-pulse basis with the returned target signal. For unequal target and reference pulses, an error signal is developed which actuates the shaft of an rf attenuator in the rf path of the reference signal, reducing the error signal to near zero. Shaft position of the attenuator is therefore proportional to target-signal amplitude, and hence to the cross-section of the target, for constant-range returns. It is concluded that the technique will provide RCS data with errors of less than 2 dB when integrated with most existing tracking radars.

5924 Paper in Abstract 5908. "The University of California Image-Plane Reflectivity Range," D. J. Angelakos and F. D. Clapp (University of California, Electronics Research Lab.), (4:0), Unclassified.

Brief description of the image-plane reflectivity range at the University of California. This single-antenna system operates at 9330 Mc and has a detection scheme of the homodyne type (superheterodyne in which the local oscillator signal is derived by frequency-shifting the basic signal with a rotating phase shifter).

5925 Paper in Abstract 5908. "Avionics Laboratory Radar Cross Section Measurements Facility," W. F. Bahret (AF Avionics Lab., Wright-Patterson AFB), (2:0), Unclassified.

A brief description of indoor RCS measurement facilities at the Air Force Avionics Laboratory. Three CW systems (S-, C-, and X-bands) and one pulsed system (X-band) are employed.

ROME AIR DEVELOPMENT CENTER (CONT.)

5926 Paper in Abstract 5908. "Radar Cross Section Measuring Equipment and Range," P. Blacksmith and R. Mack (Air Force Cambridge Research Labs.), (5:0), Unclassified.

The RCS measurement range at Air Force Cambridge Research Laboratories is briefly described. Capabilities include monostatic or bistatic measurements of missile and aircraft models at L-, S-, and X-bands. A block diagram of the X-band system is given.

5927 Paper in Abstract 5908. "The Hughes Back Scatter Measurement Range," R. E. Boucher and D. E. Ludwig (Hughes Aircraft Company, Radar Division), (10:0), Unclassified.

An outdoor, ultra-short-pulse RCS-measurement range is described. The separation of radar antenna and test object is 500 ft, which permits valid measurements of full-scale targets. Operation frequencies are in C- and X-bands; at C-band, the measurement sensitivity is -50 dBsm with a 10 dB signal-to-noise ratio, and the interference background level is below -60 dBsm. Range calibration tests are described; sample RCS data for several targets are included, along with sketches of the range geometry, a system block-diagram, and sample target returns. Among the measurements discussed briefly are signature studies on a truncated cone and a cone-sphere; effects of surface waves were noted.

5928 Paper in Abstract 5908. "Range Facilities for Measuring Radar Cross Sections of Low Density Supersonic Plasma Streams," A. I. Carswell (RCA Victor Company, Ltd., Research Laboratories), (5:4), Unclassified.

Discussion of techniques and equipment used to generate plasma streams for RCS-measurement studies; the system is designed to provide supersonic free-jet plasma flow streams with static pressures from about 0.1 to 10 Torr. Backscattering measurements have been carried out at frequencies of 9.5, 24 and 35 Gc.

5929 Paper in Abstract 5908. "The Avco RAD Vertical Range," J. F. Clougherty (Avco/RAD), (6:0), Unclassified.

Description of a vertical RCS-measurement range which consists of three 400-ft towers equiangularly spaced on a circle having a 775-ft diameter. Vehicles weighing up to 2500 lbs can be accommodated. Targets are suspended by Dacron cords. Any one of four systems may be employed: UHF, and L-, C-, or X-band. Transmitted pulsewidth is 40 nsec at a prf of 1000; 50-nsec range-gate is employed to gate the returned signal.

5930 Paper in Abstract 5908. "The Radar Reflectivity Measurement Facility at Electronic Space Structures Corporation," A. Cohen and A. P. Smolski (Electronics Space Structures Corporation), (4:2), Unclassified.

Description of a ground-plane range for RCS measurements which is 2000 ft long and 400 ft wide. The system is monostatic and employs a 100-nsec pulse radar operating at frequencies from 8.2 to 12.4 Gc; background levels on the order of -60 dBsm are achievable.

5931 Paper in Abstract 5908. "Aeronutronic Microwave Reflectivity Facility," H. G. Collins (Aeronutronic Division, Philco Corp.), (7:4), Unclassified.

ROME AIR DEVELOPMENT CENTER (CONT.)

5931 (Cont.)

An indoor anechoic-chamber measurement facility primarily intended for monostatic observations is described. Instrumentation includes two CW systems operating at C- and L-bands. Measurements of scaled models and full-scale targets are possible, but the latter are limited in size and weight. The chamber, which utilizes a longitudinal baffle, is 18 ft wide, 18 ft high, and 70 ft long. Sample data are given.

5932 Paper in Abstract 5908. "Millimetre Wave Short Pulse Radars for Indoor Echoing Area Measurements," L. A. Cram (E.M.I. Electronics Ltd.), (4:0), Unclassified.

Brief description of equipment used for measuring both monostatic and bistatic cross-sections by modeling methods. Pulse radars at 35 and 70 Gc are used indoors to measure echoes from models up to 10 ft in size. Nylon strings support the model from a gantry constructed in such a way that the reflector may be rotated.

5933 Paper in Abstract 5908. "The Lincoln Laboratory Model Backscatter Range," P. C. Fritsch, D. F. Sedivec, and A. J. Yakutis (Lincoln Laboratory, MIT), (6:0), Unclassified.

Description of an indoor RCS measurement range 113 ft long, 20 ft wide, and 12 ft high. Anechoic chambers are located at each end of the area which is divided operationally into a 35-ft-long K_a-band CW range and a 70-ft-long K_u-band pulsed range. Both systems utilize dual antennas. For the CW system, isolation between receiver and transmitter is in excess of 100 dB. The pulsed system operates with pulsewidths as short at 10 nsec.

5934 Paper in Abstract 5908. "Lockheed Missiles and Space Company Scattering Range Capabilities," N. J. Gamara (Lockheed Missiles and Space Co.), (2:0), Unclassified.

Parameters and capabilities are tabulated for six instrumentation systems for measuring RCS on the Lockheed outdoor range and for five systems to be used in an anechoic chamber.

5935 Paper in Abstract 5908. "Experimental Reflectivity Facilities," R. J. Garbacz (Antenna Lab., Ohio State University), (14:6), Unclassified.

Brief description of measurement facilities including two pulse ranges at 24 and 35.1 Gc, amplitude-only CW ranges at S- and X-bands, a CW amplitude-and-phase range at X -band, and mobile terrain equipment.

5936 Paper in Abstract 5908. "Scattering Range - the Boeing Company, Aero-Space Division," W. P. Hansen, Jr. (The Boeing Co.), (4:0), Unclassified.

Scattering-range facilities at the Aero-Space Division are briefly described. Included are two image-plane ranges at X-band, one a standard type and the other used for plasma simulation measurements; also included is an anechoic chamber for use at frequencies from 2 to 10 Gc. Two outdoor ranges are available, one at X-band and the other at several bands from 2 to 10 Gc.

ROME AIR DEVELOPMENT CENTER (CONT.)

5937 Paper in Abstract 5908. "RCS Dynamic Backscatter Testing Range," M. H. Hellman and J. M. Jarema (RCA), (4:0), Unclassified.

Description of an outdoor backscattering range designed for use in evaluating the performance of radar systems under dynamic conditions. The target-suspension scheme allows target translational speeds up to 16 fps and rotation rates up to 10 rpm over a maximum range of 200 ft. Background noise is sufficiently low that calibration is accomplished with a spherical target having a cross-section of 0.033 m^2.

5938 Paper in Abstract 5908. "Outdoor Pulsed Radar Reflectivity Range," R. E. Honer and W. D. Fortner (Micronetics Inc.), (12:3), Unclassified.

Description of two monostatic RCS-measurement ranges, one 600 ft long for L-band and lower frequencies, and the other 1000 ft long for X-band and above. Each range is paved along its full length with an inverted "V" shape; also metal barriers having inclined "V" shapes are positioned ahead of the target turntables on each range. These combinations result in a background level of -70 dBsm in absence of target and support structures. A 300-ft bistatic range at X-band is also available.

5939 Paper in Abstract 5908. "Cross-Section Range Radars at Cornell Aeronautical Laboratory," J. E. Hopkins (Cornell Aeronautical Lab.), (9:0), Unclassified.

Description of four quasi-monostatic radars used for RCS measurements: a K_a-band pulsed system, a K_a-band CW system, an X-band CW system, and an X-band FM/CW high-resolution system. All these systems are capable of operating with any linear polarization.

5940 Paper in Abstract 5908. "An Indoor Radar Scattering Range," E. F. Knott (Radiation Lab., University of Michigan), (4:1), Unclassified.

Description of an RCS measurement range comprising an anechoic chamber whose cross-section at 25 ft is -18 dBsm at S-band and -31 dBsm at X-band. Typical sensitivity for a 10-dB SNR is of the order of -50 dBsm at X-band and -40 dBsm at S-band.

5941 Paper in Abstract 5908. "Static Radar Reflectivity Measurement Facilities at Radiation Incorporated," J. E. Landfried and W. L. Williamson (Radiation Inc.), (4:0), Unclassified.

Parameters and capabilities are tabulated for ten outdoor RCS measurement systems, all pulsed systems except one CW, UHF system. Frequency coverage ranges from UHF to K_u. Various polarizations may be selected, and operating distances up to 2000 ft are available for monostatic and bistatic measurements. System arrangements are such that simultaneous operation is possible at several frequencies on separate ranges.

5942 Paper in Abstract 5908. "A Radar Backscatter Range for Measurement of Large Models," W. G. Louie and C. W. Matthis, Jr. (The Boeing Co./Wichita), (3:0), Unclassified.

ROME AIR DEVELOPMENT CENTER (CONT.)

5942 (Cont.)

Brief description of an outdoor, monostatic, CW, oblique RCS range used to measure large-scale aircraft models. Antenna-to-target separations up to 800 ft and frequency coverage from 0.3 to 40 Gc are available. A symmetrical circular tower target mount, made of foam and 12 ft high, can support models weighing up to 500 lbs. For target-to-antenna separations of 300 ft, system sensitivity is -30 dBsm.

5943 Paper in Abstract 5908. "An Ultra-High Frequency Reflection Measuring System," S. Mikuteit (Antenna Lab., Ohio State University), (8:3), Unclassified.

Description of a CW RCS measurement system used in studying echo-area control. System frequency is 422 Mc, operating ranges are variable from 30 to 103 feet, and polarizations of transmitting and receiving antennas may be continuously varied through 90 degrees. The system has a linear dynamic range of 50 dB and a sensitivity of 1 λ^2 for a target supported by a steel tower at a range of 48 ft.

5944 Paper in Abstract 5908. "Radar Echoing Area Ranges at Royal Aircraft Establishment," J. G. W. Miller and J. Edwards (Royal Aircraft Establishment), (7:0), Unclassified.

The layout and limitations of two outdoor RCS measurement ranges are described, one a pulsed X-band system and the other a CW S-band system. Models must not weigh more than 300 lbs and target dimension normal to the beam is limited to 3 ft for the X-band system and to 7 ft for the S-band system. Cross-sections may be measured to within 0.5 dB, down to -50 dBsm at X-band and -40 dBsm at S-band.

5945 Paper in Abstract 5908. "Radar Target Scatter (RAT SCAT) Site," D. Montana (Rome Air Development Center), (9:0), Unclassified.

Description of the Radar Target Scatter (RAT SCAT) site, a pulsed, range-gated, ground-plane range. Target rotators are installed at distances of 500, 1200, and 2500 ft from the radar building. Frequency coverage is continuous between 0.1 and 12 Gc, peak power is 1 kw, receiver sensitivity is -94 dBm, and linear dynamic range is 50 dB. Bistatic as well as monostatic measurements are possible. Target weights up to 8000 lbs and lengths up to 12 ft can be accommodated; if a compromise in performance is acceptable, targets up to 28 ft in length may be handled.

5946 Paper in Abstract 5908. "Investigation to Design a Method for the Analysis of Radar Cross-Section Measurement Data," M. L. Parish (The Martin Co.), (4:0), Unclassified.

A brief description of an RCS measurement chamber 20 x 20 x 50 ft. At X-band the background level was measured to be -60 dBsm at 25 ft. One end of the chamber is equipped with a drawbridge mechanism enabling the entire wall to be lowered to ground level to convert the chamber to an outdoor range terminal.

ROME AIR DEVELOPMENT CENTER (CONT.)

5947 Paper in Abstract 5908. "An Anechoic Chamber for Measurement of Backscatter Amplitude and Phase at Multiple Polarizations," R. W. Roop and S. M. Sherman (RCA, Missile and Surface Radar Division), (7:0), Unclassified.

An RCS measurement range comprising an anechoic chamber 36 x 10 x 10 ft is described; it is capable of alternately illuminating a target with waves of two orthogonal polarizations, by switching (at 400 cps) between two microwave channels. The receiver is synchronized and switched so that for each transmission period the returned signal is received and recorded for both parallel- and cross-polarized reception. System frequency is 9905 Mc.

5948 Paper in Abstract 5908. "The Scale Ground Plane Range," R. A. Ross (Cornell Aeronautical Lab.), (14:2), Unclassified.

Reports on a simulation of the full-scale RAT SCAT ground-plane range. Some discussion on the theory of the ground-plane range is included.

Note: This material is also presented in a report; see Abstract 5307.

5949 Paper in Abstract 5908. "U. S. Naval Missile Center Radar Reflectivity Measurement Facilities and Techniques," J. K. Rozendal (Naval Missile Center), (5:0), Unclassified.

Brief description of radar-reflectivity measurement facilities which include a microwave chamber, an optical-simulation facility, and AN/FPS-16 instrumentation radars. The anechoic chamber is 26 ft wide, 18 ft high, and 76 ft long. The optical simulation facility is located in a room 20 x 12 x 40 ft; surfaces of the room are painted flat black to minimize internal reflections. The C-band AN/FPS-16 radars provide permanent records of azimuth angle, elevation angle, range, tracking-error voltage, AGC voltage, and range timing.

5950 Paper in Abstract 5908. "Conductron Corporation's Radar Cross Section Range," A. W. Wren, Jr. (Conductron Corp.), (4:0), Unclassified.

Describes an outdoor RCS-measurement range for targets weighing up to 2500 lbs and an indoor anechoic-chamber range for small target models, both ranges employing CW equipment. The outdoor range has operational frequencies in UHF, L-, S-, C-, and X-bands, while the indoor system may operate in S-, C-, and X-bands. System parameters and capabilities of the ranges for the above-mentioned frequency bands are tabulated.

5951 Paper in Abstract 5908. "Description and Operation Characteristics of a Short-Pulse, Oblique Radar Cross-Section Range," M. Yaffe (General Electric Co., Missile and Space Division), (10:0), Unclassified.

Description of an outdoor facility for measuring quasi-monostatic RCS patterns of full-scale nosecones and space vehicles. Instrumentation includes a short-pulse (40 to 150 nsec) range-gated radar complex with operation capabilities at UHF, L-, and C-bands and sensitivity allowing measurements with background levels of -35 dBsm.

ROYAL AIRCRAFT ESTABLISHMENT (GREAT BRITAIN)

5952 Technical Note RAD.774, "A Mathematical Method for Estimating the Radar Echoing Properties of Aircraft," W. R. Turner, Apr 60, (20:5), Unclassified, AD 240 947.

5952 (Cont.)

Brief description of an empirical method for estimating aircraft cross-sections by combining design data, optical modeling results, and full-scale measurements. The technique was applied to the Meteor Mk. VII and the raw data obtained is tabulated, although final results are not. Echoes were assumed to comprise: skin echoes from convex surfaces, return from small scattering objects, and flashes from plane surfaces. Interest in the study was in obtaining an estimate of glint to compare with measured values for this aircraft, but the aim was not achieved. There is little new in the technique.

5953 Technical Note RAD.775, "The Improved Optical Simulator for Predicting Monostatic and Bistatic Radar Echoing Areas," J. Edwards and G. B. Gilder, Apr 60, (17:11), Unclassified, AD 245 174.

Description of an optical modeling range capable of simulating both monostatic and bistatic radar cross-sections. The model is turned in one-degree steps by a turntable and the reflected light picked up by a photo-multiplier feeds a pen recorder. Provision is made to prevent "sweating" of the model or other surfaces due to humidity, and to reduce dust which contributes to the background noise in the output.

5954 Technical Note RAD.786, "Calculation of Head-On Radar Echoes from Bodies of Circular Cross-Section by the Physical Optics Method," W. R. Turner and T. W. G. Dawson, Sep 60, (18:9), Unclassified, AD 247 604.

The physical optics method is introduced and evaluated as a means of calculating the echo areas of various metal bodies having circular geometrical cross-sections. With this method, it is assumed that electrical currents induced at any point on the surface are the same as those that would be induced on a large, flat metal sheet tangent to the surface at that point; another important assumption is that no significant radar echoes arise from electromagnetic surface waves on the object. Experimental work is mentioned which indicates that this is probably true when the surface nowhere has a radius of curvature less than about 3λ.

A general equation is developed for the echo areas of bodies having circular geometrical cross-sections, and calculated values for typical shapes are compared with values obtained experimentally. Calculated values of echo area for cone-spheres agreed reasonably well with experimental values when cone angle was small and sphere radius greater than 3λ, but incorrect results were obtained for head-on echoes of cones having the rear edge rounded-off so that it has a radius less than the cone-base radius. These limitations are considered sufficient reason to regard this method as unreliable for calculating echo areas from low-echo warheads.

5955 Technical Note RAD.787, "Calculation of the Head-On Radar Echoes from Bodies of Circular Cross-Section Using Wedge Theory," T. W. G. Dawson, J. G. W. Miller, and W. R. Turner, Sep 60, (19:10), Unclassified, AD 250 351.

This report examines the idea that the echo area of some types of bodies can be approximated by considering only the scattering from kinks (corners) in the body contour. It is assumed that smoothly-curved shapes such as cone-spheres can be regarded as being made up of a large number of elementary kinks, and formulas based on wedge theory are obtained for the head-on echo areas of

ROYAL AIRCRAFT ESTABLISHMENT (GREAT BRITAIN) (CONT.)

5955 (Cont.)

metal targets. Calculated echo areas for various bodies having circular geometrical cross-sections were compared with available experimental data. The comparisons indicate that the general formula gives results in fair agreement with experiment. Although no exact experimental data on echoes from very slight kinks was available, the formula is believed to be valid in this case; when the contour of a sphere-cone is regarded as composed of a series of slight kinks, the echo deduced is in agreement with other theories and experiments.

5956 Technical Note RAD.788, "Calculation of Radar Echoing Areas by the Cylindrical Current Method," T. W. G. Dawson and W. R. Turner, Sep 60, (39:11), Unclassified, AD 250 352.

The cylindrical-current method is used to calculate the monostatic echo area of metallic bodies of circular geometrical cross-section. With this method, it is assumed that at any point on the surface the electrical currents induced by the incident wave are approximately the same as those found on the surface of a short cylinder of the same radius; thus, a general integral was developed which could be solved to find the echo from bodies of any particular contour. Echoes from cones, cone-spheres, and spheres were calculated and appear to be in agreement with experimental data. An example was a 23-cm radius, 15° nose-angle cone-sphere; the predicted echo area was approximately 7×10^{-5} m^2 for aspects up to about $\pm 60^\circ$ from head-on. This was in fair agreement with experimental values and with values predicted by both wedge and physical-optics methods (see preceding two abstracts). In general, echo areas calculated by this method were lower than those observed experimentally in cases where surface-wave effects were important (see also following abstract).

5957 Technical Note RAD.792, "Further Calculations of Radar Echoing Areas by the Cylindrical Current Method," W. R. Turner, Dec 60, (30:5), Unclassified, AD 251 697.

This report represents an extension of the work described in the preceding abstract. The cylindrical-current method is considered as a technique for investigating the echo area of a rounded flat-backed cone. From the experimental and calculated data presented, it appears that a cone-sphere back can be considerably flattened without significantly altering the short-wavelength echo near head-on. It also appears that the cylindrical-current method of evaluating echo areas from metal bodies of circular geometrical cross-section gives reliable results for cone-spheres and allied shapes for angles between about 15° off head-on and broadside, provided that there are no surface-wave effects, and that the surface of the body is reasonably free from minor undulations and irregularities. Both theoretical and experimental data indicate that the fall-off of the broadside flash is sharper for rounded flat-backed cones than for cone-spheres.

5958 Technical Note RAD.846, "I.L.S. Localiser Feasibility Study: The Measurement of the Bistatic Echoing Areas of Model Aircraft as an Aid to the Evaluation of the Problem of Interference from Overflying Aircraft," P. Bowron, Aug 63, (45:7), Unclassified, AD 428 826.

ROYAL AIRCRAFT ESTABLISHMENT (GREAT BRITAIN) (CONT.)

5958 (Cont.)

The purpose of this project was to investigate methods of reducing interfering signals from overflying aircraft during the automatic landing approach of another aircraft. Bistatic radar echo patterns were measured for several aircraft models, including Comet, Valiant, Victor, and Vulcan. The measurements were taken with a X-band pulsed system at a range of 150 ft. They were made at 30° intervals from 0° to 120° for aspect angles of ±90°, from both nose-down and wing-down configurations (20° from horizontal). The measured echo patterns were used to estimate the volume of airspace within which an overflying aircraft might cause interference with landing aircraft. It was found that, for certain positions, overflying aircraft may present echo areas as great as 3000 m^2.

5959 Technical Note RAD.850, "Limitations to Accuracy Attainable with the R.A.E. X-Band Echoing Area Measuring Equipment," J. G. W. Miller, Sep 63, (38:2), Unclassified, AD 428 083.

An investigation of improved methods of determining the aspect angles of models for measurements made with the R.A.E. X-band radar-echo measuring equipment and outdoor range. The goal was to determine ways of increasing the accuracy in measuring lobe structures so that the basic mechanisms of various echo sources could be investigated. Three methods were considered for determining aspect angles: (1) the motion of the freely rotating model was photographed; (2) the model was allowed to rotate freely and aspect angles determined relative to known angular positions of recognized lobes; and (3) aspect angles were related to angle through which the projection of the model turns in a horizontal plane. (The latter angle and the aspect angle are not the same unless the model's axis of symmetry is perpendicular to the axis of rotation and the radar beam lies in the plane of rotation.) The third method is most accurate and is discussed in detail. Method (2) provides accuracies to within a few degrees only; brief discussion on this method and errors from its use are presented in an appendix. Method (1) was regarded as unsatisfactory and is not discussed. Under favorable weather conditions, the angular data was determined experimentally through a range from 0° to 90° with an accuracy of roughly ±1°.

5960 Technical Note RAD.852, "Reflection of Surface Waves at Abrupt Discontinuities," J. G. W. Miller, Nov 63, (19:8), Unclassified, AD 432 461L.

Analysis of the mechanism of reflection at abrupt discontinuities for induced electromagnetic waves flowing along a straight metal surface. (Such reflections lead to traveling-wave echoes.) Particular reference is made to the reflections from biconical structures at X-band. The severity of the geometrical discontinuity presented by the junction of the cones is related empirically to the magnitude of the reflection coefficient.

5961 Technical Note RAD.857, "Automatic Landing Monitoring Using Reflected Signal Analysis," J. Benjamin, Feb 64, (10:3), Unclassified, AD 438 806.

Proposal of a monitoring method which enables signals received and reflected by a landing aircraft to be analyzed to assess the presence or absence of unfavorable interfering signals on a VHF instrument landing system (ILS), and to analyze the output signals of an ILS receiver. These output signals will be

ROYAL AIRCRAFT ESTABLISHMENT (GREAT BRITAIN) (CONT.)

5961 (Cont.)

used to display the frequency and amplitude of signals reflected from the aircraft. Reflectivity characteristics of the aircraft are not considered.

ROYAL CANADIAN AIR FORCE

5962 Report DEW/REF. VF 63/1, "Aurora Polaris. Part II - The Radio Aurora," J. M. MacDonald, 8 May 63, (24:36), Unclassified, AD 411 307.

This brief tutorial report describes very general characteristics of the ionosphere and aurora. Highlights of auroral radio research are reviewed without mathematical treatment. Qualitatively described are the types of radio aurora and their important characteristics, and theories to explain the radar-auroral reflection mechanism; auroral echoes are also correlated with other geophysical phenomena. Characteristics discussed are: (1) aspect sensitivity; (2) height of reflecting region; (3) range distribution; (4) range drifts and Doppler shifts; (5) frequency dependence and polarization of echoes; (6) amplitude distribution of auroral echoes; and (7) scattering area of aurora.

ROYAL CANADIAN NAVY, DIRECTORATE OF OPERATIONAL RESEARCH

5963 Final Report on Project OPVAL SE 67, "Evaluation of Standard RCN and Commercial Life Rafts," 5 Aug 59, (60:-), Unclassified, AD 253 581.

Radar reflectors for use with life rafts were considered very briefly during an evaluation of five types of life rafts.

ROYAL RADAR ESTABLISHMENT (GREAT BRITAIN)

5964 Technical Note 655, "The Effect of the Weather in Eastern England on the Performance of X Band Ground Radars," W. J. James, Jul 61, (48:12), Unclassified, AD 264 418.

Survey of various types of rain and clouds and their contribution to signal attenuation and PPI-scope clutter on an X-band radar. It is pointed out that the amount of attenuation caused by rain is related to radar wavelength as well as to both diameter and concentration of water drops. However, at X-band, rain will produce significant attenuations only at elevation angles of about 1° or less. PPI clutter is reported to degrade radar performance much more than does attenuation. Methods of overcoming PPI clutter are discussed briefly; it was found that circular polarization can reduce rain echoes by 20 to 26 dB while aircraft echoes are reduced only by about 1 dB. The appendices contain a critical survey of the formulas used for calculating the amplitude of rain echoes, and suggest a formula which would reduce the known discrepancy between calculated and measured results.

SMYTH RESEARCH ASSOCIATES

5965 "Shield Method for Solution of Geometric Problems Involving Reflection from Field Aligned Ionization," S. Weisbrod and L. A. Morgan, AF 30(602)-1624, Feb 61, Unclassified.

Report SRA-173: Part II	Pages:Refs	AD No.
Vol. I (RADC-TR-61-224B)	85:6	267 544
Vol. II (RADC-TR-61-224C)	112:0	267 545

SMYTH RESEARCH ASSOCIATES (CONT.)

5965 (Cont.)

Geometric problems of transmission paths involving specular or arbitrarily off-specular reflection from field-aligned ionization can be solved with the aid of a technique using charts called "shields." The method is rapid, accurate, and easy to apply. Since no approximations were made in its development, it is valid for all antenna-beam orientations and for any part of the world. It is applicable to monostatic, bistatic, and polystatic transmission paths. In Volume I, are presented detailed descriptions of the charts, and their application to specific problems. In addition, a family of shields is included for the most common reflection height of 110 km, at 1° increments of geomagnetic latitude. Volume II contains shields for reflection heights of 75, 90, 100, 120, 150, 200, 300, and 400 km at 5° increments of geomagnetic latitude.

SPACE SYSTEMS DIVISION, AIR FORCE SYSTEMS COMMAND

5966 SSD-TDR-63-389, "An Annotated Bibliography of Space Vehicle Re-entry and Associated Phenomena," R. H. Schorsch, Oct 63, (458:1150), Unclassified, AD 427 564.

Listing of some 1150 classified and unclassified references issued between January 1956 and March 1963, which pertain to various phenomena of space vehicle re-entry, including aerodynamics and heat-flow. Most entires include descriptive abstracts and some are pertinent to radar reflectivity. Entries are numbered consecutively within alphabetical sections according to author's name.

STANFORD RESEARCH INSTITUTE

5967 Scientific Report 13 on SRI Project 1422, "Ground Illumination Pattern of Signals Reflected from a Meteor Trail," E. M. Young and I. W. Yabroff, AF 19(604)-1517, Dec 59, (77:16), Unclassified, AD 231 122.

Calculation of the ground-illumination pattern of a signal reflected from an arbitrarily oriented meteor trail, based on a physical model involving a finite trail length and a radial distribution of electrons (forming a cylinder) according to Eshleman's theory (see Abstract 2608.) Equations are developed showing the reflection of a signal from a chosen trail to the earth's surface, and a number of graphs are presented of ground-illumination patterns. The work is aimed at providing basic information for the design of meteor communication networks.

5968 Final Report on SRI Project 1422 (AFCRC-TR-59-367), "A Summary of Literature Pertaining to Radio Studies of Meteors and Meteor Trails," W. R. Vincent and F. H. Smith, AF 19(604)-1517, Jan 60, (387:1000+), Unclassified, AD 231 809.

Comprehensive survey of the literature pertinent to radio studies of meteors. An abstract is given of each article, report, or book available in English. A separate list without abstracts is given of material published in the Soviet Union and in Eastern European countries. Over 1000 documents are listed; unpublished reports presented at meetings or symposia are not included.

STANFORD RESEARCH INSTITUTE (CONT.)

5969 Technical Report 1 on SRI Project 1620 (RADC-TN-57-110), "Predicted Characteristics of Meteor Reflections at Radio Frequencies Above 100 Mc," W. R. Eshleman, L. A. Manning, and A. M. Peterson, AF 30(602)-1462, Feb 57, (50:41), Unclassified, AD 114 367.

Characteristics are predicted of the meteor echoes which can be detected by high-sensitivity monostatic or bistatic radars at wavelengths between about 0.3 and 30 meters. Past experimental and theoretical investigations of meteor echoes in the wavelength range from 3 to 30 meters are reviewed, along with recent theoretical investigations of echo characteristics at wavelengths shorter than 3 meters. The analysis includes the following topics: the numbers, intensities, durations, polarizations, and Doppler frequencies of the echoes; and the variation of these factors with time of day and season, and with various system parameters such as wavelength, power, and sensitivity.

Note: For the Final Report on this project, see Abstracts 2606 and 2607.

5970 Final Report on SRI Project 2225, "Upper Atmosphere Clutter Research," Contract AF 30(602)-1762, Unclassified.

This program involved a variety of studies relating to the upper atmosphere, including both natural phenomena and satellites. The final report comprises a number of individual documents, each concerning some specific study; those pertinent are abstracted below. While each document is complete in itself, none of those received contained any overall summary or description of the program as a whole.

5971 Final Report-Part I, "VHF and UHF Auroral Investigations at College, Alaska," R. I. Presnell, R. L. Leadabrand, R. B. Dyce, et al., Apr 59, (81:8), AD 211 937. (For program description, see Abstract 5970.)

Presents results of radar investigations of aurora at frequencies of 216, 398, and 780 Mc. Echo characteristics measured were range, range depth, bearing, elevation angle, height, strength, times of occurrence, duration of echoes, and polarization effects. Echo characteristics were compared with visual aurora, magnetic activity, earth potential, 41-Mc auroral radar data, and auroral absorption. An indication of the aspect sensitivity of the auroral reflections was obtained, along with crude estimates of the wavelength dependence of reflected echo power. The most significant result was that two distinct echo types were shown to exist--discrete, which occur mainly at night, and diffused, which occur mainly during the day. Doppler spectra of 398-Mc auroral reflections were obtained for both discrete and diffuse echoes. Maximum Doppler shifts measured were ±6 kc, and spreads of as much as 3 kc were noted. The ratio of powers received at two wavelengths was found to vary directly as the ratio of the wavelengths to the power 5±2 for discrete echoes, and the power 3±2 for diffuse echoes.

5972 Final Report-Part II, "High Altitude 106.0-Mc Radar Echoes from Auroral Ionization Detected at a Geomagnetic Latitude of 43 Degrees," J. C. Schlobohm, R. L. Leadabrand, R. B. Dyce, et al., Apr 59, (27:11), AD 212 617. (For program description, see Abstract 5970.)

This is a report of an attempt to determine if auroral echoes can be obtained from ionized trails at altitudes up to 300 km. Observations were made with a 106.0-Mc radar located at 43° geomagnetic latitude, where the geometry of reflection with the earth's magnetic field lines is such that

STANFORD RESEARCH INSTITUTE (CONT.)

5972 (Cont.)

reflection as high as 300 km is possible. The geometry of auroral reflection is examined and typical loci of reflection centers are presented, showing contours of the perpendicular intersection of radar rays and the earth's magnetic field at several heights for radar sites at various latitudes. From the numerous A-scope displays of the auroral echoes with both horizontally and vertically polarized receiver feeds at various elevation angles, it is noted that the strongest echoes are always received with the same polarization as that transmitted, and that there is generally no detectable return at all for the orthogonal polarization. From photographs of range-azimuth displays, the U-shaped trend of the aurora is observed. Auroral echoes observed at a 300-km height illustrate the fallacy of an earlier assumption that auroral reflection centers are at an altitude of 100 km only.

5973 Final Report-Part III (RADC-TN-59-45), "Russian Earth Satellites 1957 Alpha and Beta Radio and Radar Data and a Simple Satellite Position Prediction Technique," W. E. Jaye and L. H. Rorden, May 59, AD 212 618. (For program description, see Abstract 5970.)

Radio and radar observations on the first two earth satellites are summarized and analyzed. The report also contains analysis relating to the prediction of satellite position. A radar was pointed in the direction of predicted closest approach and the satellite allowed to move through the beam. Essentially all data presented pertain to orbital parameters and no reflectivity information is included.

5974 Final Report-Part IV (RADC-TR-59-158), "Analysis of Radar Echoes Obtained from Earth Satellites 1957 Alpha and 1957 Beta," W. E. Jaye, R. B. Dyce, and R. L. Leadabrand, Oct 59, (45:6), AD 228 272. (For program description, see Abstract 5970.)

An analysis of radar measurements of satellites 1957 Alpha and 1957 Beta, in order to study propagation through the atmosphere using the satellite as a reflector and measuring the Faraday rotation. The 60-kw, 106.1-Mc radar had a 61-foot, steerable parabolic reflector. Experiments to measure the Faraday rotation were unsuccessful due to lobing caused by satellite tumbling. Forty-two echoes obtained from 1957 Beta were analyzed. The apparent cross-section most often detected was on the order of 1 m^2. The largest apparent cross-section detected was 437 m^2. Lobing frequency varied between 0.1 and 0.9 cps.

5975 Final Report-Part VII (RADC-TR-59-50), "Doppler Investigations of the Radar Aurora at 400 Mc," R. L. Leadabrand, R. I. Presnell, M. R. Berg, and R. B. Dyce, Mar 59, (40:11), AD 213 581. (For program, see Abstract 5970).

The variation of Doppler shift of auroral echoes was observed with a relatively sensitive 400-Mc, narrow-beam radar located at College, Alaska. Doppler shifts of auroral echoes were determined as a function of azimuth and elevation angles of the radar ray, off-perpendicular intersection angle between radar ray and earth's magnetic field, echo range, reflection-center altitude, time of day, number of occurrences, and echo amplitude. These data are further delineated in terms of the type of echo seen (discrete or diffuse), and whether or not the data were taken before or after magnetic midnight. An estimate of the spectral spread of auroral echoes is determined from pulse and CW techniques.

STANFORD RESEARCH INSTITUTE (CONT.)

5975 (Cont.)

A consistent trend in the data indicates an east-west motion of these ionospheric irregularities, with no appreciable variation in the direction of motion with time of day or with respect to magnetic midnight. Several photographs are shown of pulse and CW auroral spectra showing positive and negative shifts, along with numerous scatter plots of Doppler shift vs. azimuth, off-perpendicularity angle, elevation, range, height, time of day, and signal-to-noise ratio for discrete data only, diffuse data only, and for all data.

Note: Part VI is on hard-tube TR techniques and is presumed to contain no reflectivity information.

5976 Final Report-Part VIII (RADC-TR-60-25), "VHF and UHF Meteor Echo Investigations," R. L. Leadabrand, Feb 60, (-:18). (For program description, see Abstract 5970.)

(BD-809) No abstract available.

5977 Final Report-Part IX (RADC-TR-60-26), "Investigations of Moon Echoes," R. B. Dyce, Jan 60, (78:24), AD 236 853. (For program, see Abstract 5970.)

Radar investigation of the moon's surface reveals that there is a strong echo from the initial contact with the front face, followed by lesser echoes from more distant portions of the surface. This rough nature is responsible for rapid, irregular amplitude fluctuations at a rate of about 1 cps. Because of the range extent of the lunar echo, a transmission having a bandwidth wider than a few kilocycles is likely to be garbled. In the process of scattering from the surface, a linear polarization is apparently reflected with little change, except for the introduction of a small quantity of cross-polarization. Signals observed with two antennas and receivers separated on the order of one kilometer show libration fading envelopes essentially uncorrelated. The presence of aurora between radar and moon roughly doubles the integrated electron density above normal values observed in the Arctic. Also studied is the Faraday rotation of lunar-reflected signals in the ionosphere.

Note: Part X is entitled "Analysis of Radio Satellite Transmission," Unclassified, AD 234 796.

5978 Final Report-Part XI (RADC-TR-60-28), "Some Characteristics of VHF and UHF Auroral Reflections," R. L. Leadabrand, Mar 60, (248:3), AD 236 926. (For program description, see Abstract 5970.)

Analysis of auroral data which was collected at Stanford, California, at 106.1 Mc and at College, Alaska, at 216.4, 398, and 780 Mc in an attempt to establish the characteristics of auroral reflections at frequencies between 100 and 800 Mc. Pulse-to-pulse fading of various types of auroral echoes is analyzed; the results and usefulness of an examination of the fading spectra of the aurora as seen within a single auroral pulse are discussed. An attempt to obtain a model which will adequately explain the mechanism of scattering from auroral ionization reveals the most important characteristics to be the variation with frequency both of aspect sensitivity and of scattered-signal intensity. The scattering mechanism is examined in detail with consideration of a model for backscattering from elongated field-aligned irregularities of electron density. Irregularities are attributed to atmospheric turbulence, charged particles which produce auroral ionization by following magnetic lines, and electric fields which cause current systems to flow in the upper atmosphere during auroral

STANFORD RESEARCH INSTITUTE (CONT.)

5978 (Cont.)

disturbances. The appendices, which comprise 208 pages of this 248-page report, present graphs, histograms, and scatter diagrams of the vast amount of data collected in this study.

5979 Final Report-Part XIII (RADC-TR-60-44), "Effects of the Atmosphere on Radar Resolution and Accuracy," Apr 60, AD 238 407. (For program description, see Abstract 5970.)

(BD-1323) This report presents results of a study to assess the limitations placed on radar resolution and accuracy by the earth's atmosphere. The first section summarizes the detailed discussions following, and presents pertinent material from current literature. The summary briefly states current knowledge of the troposphere and ionosphere, discusses the effects of the atmosphere on radar resolution and accuracy, and presents a compilation of the variation of these limitations throughout the frequency range from 100 Mc to 30 Gc. It is concluded that the frequency range to achieve optimum resolution lies between 3 and 10 Gc. In this frequency band, angular resolution of 10^{-4} to 10^{-5} radians and range resolution of a fraction of one meter should be achievable. Unless corrections are applied, mean angular errors of 10^{-3} to 10^{-4} radians and mean range errors of 3 to 10 meters can be expected. Experiments have not yet been conducted with a degree of precision sufficient to confirm the expected accuracy and resolution limitations.

5980 Technical Report 64 on SRI Project 2494 (AFCRC-TN-58-190), "The Back-Scattering Cross Sections of Missile Trails," C. Flammer, AF 19(604)-3458, Jun 58, (-:64), Unclassified, AD 152 442.

(BD-1462) The boundary surface of the overdense part of the trail of a guided missile is estimated by considering jointly the processes of ambipolar diffusion and of recombination of electrons and positive ions in the exhaust gas. A lower limit to the maximum backscatter cross-section is obtained. Numerical results are presented for three different values of diffusion coefficient and for several values of recombination coefficient.

5981 Interim Report 3 on SRI Project 2532, "Airborne Jamming Antenna Study. Scattering and Absorption by a Receiving Antenna," M. G. Andreasen, AF 33(616)-5584, Apr 60, (32:7), Unclassified, AD 236 342.

A simple physical picture is presented of the mechanism of absorption and scattering by receiving antennas. The currents induced in an antenna are assumed to be separated into loaded and unloaded currents. Loaded currents couple power to the antenna load and scatter with the transmitting pattern in a direction opposite to that of transmission. The unloaded currents (which are often very weak) do not couple power to the antenna load, but rather scatter with a pattern which is at best difficult to find by simple means. The fields backscattered by these currents are derived for a few simple cases, including a small dipole, a parabolic horn, and a hog horn. Appendices discuss the relation between power absorbed and power scattered both by a matched, lossless antenna and by a traveling-wave antenna.

STANFORD RESEARCH INSTITUTE (CONT.)

5982 Final Report on SRI Project EU 2580 (AFCRL-TR-61-200), "Research Toward Effective Use of Weather Radar Data in Weather Analysis and Forecasting," M. G. H. Ligda, S. M. Serebreny, and R. E. Nagle, AF 19(604)-3067, Jan 61, (82:15), Unclassified, AD 267 539.

Documentation of a continental radarscope photography program and a study of the automatic processing of weather-radar data. Radar observations of a deep, extratropical storm, which formed as a wave on a polar front, were used to study the relationships between synoptic-scale precipitation patterns and other meteorological parameters. The development of the storm is discussed in detail, with emphasis on interaction of synoptic meteorological developments with terrain features. A detailed description and evaluation of the precipitation patterns and their spatial and temporal variations as seen on the numerous radarscope composite charts is provided. The relationships between synoptic-scale radar precipitation observations, moisture-wind distribution, and advection patterns are also discussed. The application and significance of synoptic-scale radar observations to weather analysis and prediction are discussed. Studies of four storms indicate that spiral-banded echoes appear on many occasions and many scales other than those associated with hurricanes and tornadoes, and that storms having similar origins and natures may have startlingly similar precipitation patterns. Also studied was the question of the optimum time compression needed for analyzing various storm features.

5983 Preliminary Report 2 on SRI Project 2604, "Evidence that the Moon is a Rough Scatterer at Radio Frequencies," R. L. Leadabrand, R. B. Dyce, J. C. Schlobohm, et al., AF 30(602)-1871, Feb 60, (21:6), Unclassified, AD 240 790.

Radar echoes from the moon were observed at 400 Mc to determine scattering properties of the lunar surface. Results go beyond investigations of other authors who claim that the moon is a quasi-smooth reflector having a range depth of less than 600 μsec. Results indicate that while the moon behaves as a quasi-smooth reflector in the range depth 0 to 600 μsec, beyond this range it behaves as a uniformly rough scatterer, giving echoes out to one lunar radius, i.e., to the limb of the visible half of the surface. An empirical fit to the integrated range-vs.-time display provides an angular scattering law for each infinitesimal element of the surface given by:

$$P(\Phi) \propto (\sin \Phi/\Phi)^{20\pm 6} + 1/10, \qquad -\pi < \Phi < \pi.$$

A procedure is suggested for mapping details of the lunar surface by radar, using range and Doppler-shift coordinates; this technique does not require angular resolution.

5984 Field Report IV on SRI Project 2750 (AFCRC-TN-59-980), "Auroral-Like Radar Echoes Observed from 17 Degrees Latitude," R. B. Dyce, L. T. Dolphin, R. L. Leadabrand, and R. A. Long, AF 19(604)-5209, Aug 59, (-:8), Unclassified.

(BD-801) Anomalous echoes are regularly observed by a shipborne radar located at Antigua. These echoes, observed at 32 and 140 Mc, have many of the characteristics of echoes from the aurora observed in the arctic, although visible aurora should not be observable at Antigua more frequently than once in seven years. Similar observations at Stanford University indicate a correlation with one kind of sporadic-E ionization.

STANFORD RESEARCH INSTITUTE (CONT.)

5985 Final Report on SRI Project 2829, "A Radar Study of Maritime Precipitation Echoes," M. G. H. Ligda, R. T. H. Collis, and R. H. Blackmer, Jr., NOas 59-6170-c, Jun 60, (57:9), Unclassified, AD 241 644L. (Government agencies only from DDC; others to Chief, Bureau of Naval Weapons, Washington, D. C. 20360.)

An exploratory investigation was made of weather observation by radar in the eastern North Pacific Ocean. A radarscope-photography program was conducted for a period of one year by ships of RADRON I, the radar picket squadron that patrols on a line about 300 miles west of the U. S. Pacific coast. The PPI-scope film records discussed include maritime precipitation echoes, swell waves, ordinary sea clutter, and echoes from land targets up to about 500 miles distant as a result of strong superrefraction of the radar beam. Echo patterns are correlated with meteorological patterns and characteristics, in particular cyclonic and anticyclonic fronts. Echo patterns and motions in revolving storms are also treated as well as sea return under anomalous (ducting) propagation conditions. Operational application of the results are considered. Radar types and frequencies are not given.

5986 Final Report on SRI Project 2909, "An Investigation of the Backscatter of High-Frequency Radio Waves from Land, Sea Water, and Ice," D. Nielson, G. Hagn, L. Rorden, and N. Clark, Nonr-2917(00), May 60, (141:11), Unclassified, AD 238 811.

An airborne high-frequency (32.8 Mc) radar was used to investigate backscatter from the earth's surface, and qualitative results are given for the ocean, polar ice, level land, and mountains. An idealized backscatter coefficient is derived, and the radar system is qualitatively described. Almost half of the report is made up of raw data chosen to show the typical activity for each type of terrain. Results indicate that electrical properties of terrain lose their importance at low aspect angles, while both roughness and electrical properties are important at high aspect angles. Backscatter from permanent ice seems to depend more on physical characteristics than on electrical characteristics. Mixed land and water surfaces, water, and smooth ice give a higher return using vertical polarization. Coastline contrasts are best using horizontally polarized signals.

Note: An extensive errata sheet has been issued on this report; in particular, the expression for ρ in Equations 14 and 16 on page 16 should be multiplied by π and the curves of Section VI adjusted by this amount. A subsequent report summarizes this program and points out some overall problems (see next abstract).

5987 Final Report II on SRI Project 2909, "An Investigation of Direct Backscatter of High-Frequency Radio Waves from Land, Sea Water, and Ice Surfaces," G. H. Hagn, Nonr-2917(00), May 62, (228:29), Unclassified, AD 278 138.

An airborne HF radar operating at 32.8 Mc was used to investigate backscatter from such terrain types as ocean, polar sea ice, and selected land surfaces. This report presents the resulting data and conclusions drawn therefrom. Most of the raw data takes the form of graphs of reflection coefficient vs. incidence angle. Results indicate that at a wavelength of 30 ft, surface roughness is the dominant characteristic in determining the amount of backscatter for specified incidence angle and polarization. There is, however, no adequate quantitative roughness parameter with which to associate the optically observed scattering surface with the radar echoes that it produces.

5987 (Cont.)

For surfaces with roughness small compared to 30 ft, backscatter reflection coefficient is strongly dependent on depression angle, and polarization effects are pronounced. There is no orderly angular dependence for either polarization when the surface is rough. The relative strength of echoes from land and sea depends on incidence angle, mean ground level, polarization, and surface roughness. Normally the ground gives greater echoes near grazing for both polarizations. Strong geometrical enhancement was observed at land-sea interfaces viewed from the sea. Enhancement was also observed over mountains. Ocean and sea ice data were regular and very similar. One data sample taken over smooth ice indicates that the cross-polarized component from such a surface may be down only 10 dB.

Note: An earlier report (preceding abstract) presents raw data and discusses this program. There is some question that these data are completely valid (Ed: In particular, sea return with horizontal polarization appears to be too high and to increase too fast with grazing angle.), and the author comments on various problems. The program is valuable, however, since HF data are very sparse.

5988 Scientific Report 1 on SRI Project 2986, "Cloud Shield and Radar Precipitation Echo Relationships with Satellite Applications," F. L. Ludwig and R. E. Nagle, AF 19(604)-5982, Apr 60, (97:6), Unclassified, AD 240 437.

Numerous composite radarscope photographs, taken with land, ship, and airborne radars, show echoes from precipitation, frontal areas, and total cloud cover over sections of the mid-United States and eastern Pacific. These are accompanied by analyses of low, middle, and high cloud shields. Cloud-precipitation relationships are discussed and characteristics of the cloud patterns which seem, from the composite analyses, to be associated with precipitation or storm systems are discussed in terms of the likelihood that they might be discerned from satellite photographs.

5989 Technical Progress Report 2 on SRI Project 2986, "Research Directed Toward the Use of Synoptic Radar Observations in the Interpretation of Satellite Cloud Observations," R. E. Nagle, R. H. Blackmer, and M. G. H. Ligda, AF 19(604)-5982, 30 Jun 60, (20:-), Unclassified, AD 244 732.

Optical and photographic rectification techniques are proposed to provide a method by which segments of successive satellite cloud pictures can be made compatible with radar composite charts. Experience with rectifying procedures leads to the assumption that it is not feasible to rectify whole satellite pictures to projections comparable with those in the construction of radarscope composites accurately enough to make possible specific comparisons. The difficulties in rectifying satellite cloud pictures are discussed with a brief consideration of the use of radar echoes for exact positioning of cloud pictures.

5990 SRI Project 3311, "Backscatter Literature Survey," G. H. Hagn, D. L. Nielson, and F. H. Smith, SD-66, Jun 61, (376:400+), Unclassified, AD 264 460.

STANFORD RESEARCH INSTITUTE (CONT.)

5990 (Cont.)

Author's abstracts of more than 400 unclassified references on ionospheric backscatter which appeared between 1928 and 1960. Entries are arranged in three sections by subject: ionospherically propagated ground backscatter and related subjects, terrain return, and direct backscatter from discrete objects; many are pertinent to radar reflectivity. Foreign-language publications are collected in another section. In each section, abstracts are arranged alphabetically by author. (See also next abstract.)

5991 SRI Project 3311, "Backscatter Literature Survey," G. H. Hagn and L. R. McAfee, SD-66, ARPA Order 365, Oct 64, Unclassified.

(BD-8330) A bibliographical survey of backscatter literature, extending that described in the preceding abstract and covering the period December 1960 through December 1963. Authors' abstracts have been included whenever they are available. Pertinent abstracts dated prior to 1961 which did not appear in the first edition and a number of articles published in 1964 have been included. This survey covers ionospherically propagated backscatter at HF. Abstracts dealing with other relevant topics (terrain return, scattering from discrete objects, incoherent backscatter, lunar echoes, etc.) have been included, as is some pertinent information on geophysical conditions.

5992 Final Report on SRI Project 3338 (AFCRL-654), "High Altitude Weather Hazards to Flight," R. E. Nagle, AF 19(604)-7397, Jul 61, (56:31), Unclassified, AD 266 154.

Analysis of radar and synoptic data from 14 severe thunderstorms which were involved in the damage or destruction of aircraft above 25,000 ft. Although the radar echoes associated with high-level hazardous flight conditions appear to have the same general characteristics, it is suggested that their patterns may be classified into three broad types; these are illustrated in PPI displays. Sharp echo "spikes" that were observed are attributed to hail shafts. Methods for combined radarscope and wind-field analysis are presented in an appendix.

5993 Technical Report 1 on SRI Project 3857, "Feasibility Study of the Development of a Digital Computer Routine for the Simulation of Radio Frequency Backscatter from Space Vehicles and of Mathematical Methods for Analyzing Digitalized Backscatter Data," R. C. McCarty, W. C. Cutler, and G. W. Evans II, SD-103, ARPA Order 281-62, Feb 62, (42:8), Unclassified, AD 416 573 or AD 434 855.

This report describes preliminary analyses to delineate computer routines for simulating backscatter from space vehicles and analyzing digitalized backscatter data. Portions are written as an exposition of the analytical methods developed in the previous works of referenced authors.

5994 Memorandum Report 1 on SRI Project 3857, "Objectives and Plans for Mathematical Investigations of Radio Frequency Backscatter from Missiles," G. W. Evans II, R. C. McCarty, and W. C. Cutler, SD-103, ARPA Order 281-62, Mar 62, (10:1), Unclassified, AD 273 442.

STANFORD RESEARCH INSTITUTE (CONT.)

5994 (Cont.)

Brief general comments on questions of data handling and analysis relating to the problem of identifying missiles from radar and other observations.

5995 Semi-Annual Technical Summary Report on SRI Project 3857, "Research on Ballistic Missile Defense Phenomenology: Part One," C. Flammer, editor, SD-103, ARPA Order 281-62, Mar 62, (78:64), Unclassified, AD 274 610.

This document summarizes work performed on electromagnetic scattering from plasma, atomic and chemionization processes, simulation techniques, and theoretical missile phenomena. The section on scattering deals primarily with techniques and equipment for thermal and shock-tube generation of plasmas. Very little of the report is pertinent to reflectivity characteristics.

5996 Technical Report 3 on SRI Project 3857, "Computer Simulation Routine for Radio Frequency Backscatter: Some Computer Subroutines for the Analysis of Digitalized Stationary and Ergodic Data," G. W. Evans II, R. C. McCarty, W. C. Cutler, and L. Leving, SD-103, ARPA Order 281-62, May 62, (22:2), Unclassified, AD 277 265.

Some digital computer subroutines which may be used in analyzing digitalized data of continuous backscattering signals from space vehicles. Included are analytic procedures and definitions, their approximations, and flow diagrams for the computer subroutines.

5997 Technical Report 5 on SRI Project 3857, "Computer Simulation Routine for Radio Frequency Backscatter: First Preliminary Model," G. W. Evans II, R. C. McCarty, P. H. Omlor, and L. Leving, SD-103, ARPA Order 281-62, Sep 62, (70:7), Unclassified, AD 287 664.

Description of a computer routine which simulates the path of a ballistic missile and the behavior of its cross-section. The mathematical model was chosen principally to test mathematical methods for analyzing digitalized samples of simulated cross-section amplitude data. The analysis method assumes that the data represent stationary and ergodic processes, whereas the simulated data samples are taken from a quasi-stationary process. Although stress is on testing the methods of analysis, care was taken to have a reasonable simulation of the backscattered signal from an oscillating missile; however, wake, plasma, and shock effects were not included in the model. The computer program is given in an appendix.

5998 Technical Report 6 on SRI Project 3857, "Electromagnetic Scattering from Extended Targets," H. S. Rothman, H. Guthart, and T. Morita, SD-103, ARPA Order 281-62, Sep 62, (44:8), Unclassified, AD 290 089.

Experiments are reported on interference and resolution effects and pulse broadening in the reflection of short-pulse signals from spatially extended targets or arrays of point targets. The work was aimed at developing a better understanding of observed properties of reflections from re-entry wakes. An X-band radar having a pulsewidth of 1 nsec was used to examine reflections from arrays of dipole scatterers and from a dielectric cylinder. Preliminary results are also given for scattering from a laminar plasma column in a low-pressure vessel. The experiments are backed up by short analyses of several aspects of the subject, including a Fourier analysis of the return from an extended target.

STANFORD RESEARCH INSTITUTE (CONT.)

5999 Final Technical Summary Report-Part I on SRI Project 3857, "Research on Ballistic Missile Defense Phenomenology," C. Flammer, editor, SD-103, ARPA Order 281-62, Dec 62, (45:18), Unclassified, AD 298 573.

Summarizes the progress on a study of phenomena related to ballistic-missile defense systems for the twelve-month period ending 30 September 1962; abstracts are presented of technical reports issued during the period. The subjects covered in Part I include: (1) new methods of analyzing non-stationary stochastic processes and the development of computer routines that simulate digitalized data representing backscatter from missiles; (2) studies of electromagnetic interactions with ionized media; (3) various theoretical studies on disturbances and waves induced in the upper atmosphere by missiles; and (4) a study of the potential effectiveness of proposed discrimination techniques for terminal defense systems.

6000 Technical Report 10 on SRI Project 3857, "Electromagnetic Scattering from an Extended Laminar Plasma Column," H. S. Rothman, SD-103, ARPA Order 281-62, Unclassified, AD 416 571.

Examination of backscattering from a simplified ionized target in the form of an extended laminar plasma column. Measurements on laboratory plasma columns were compared with calculations incorporating measured electrical parameters of the column and based on existing theory. Results show that the backscatter cross-section can be determined to within 1 dB. Instrumentation and experimental techniques are described in detail. Two short appendices deal with the calculation of backscatter cross-section for an extended cylindrical target.

6001 Memorandum Report 5 on SRI Project 3857, "An Outline and Discussion of Three Proposed Methods for the Data Analysis of Radar Return Pulses," G. W. Evans II, R. C. McCarty, and G. L. Sutherland, SD-103, ARPA Order 281-62, Aug 63, (36:3), Unclassified, AD 418 485 or AD 418 089.

Description of three extensions to the power spectral density (PSD) method (Technical Reports 4 and 12 on SRI Project 3857) for analyzing a sequence of radar returns from a target. Previously the PSD method has been used to analyze data obtained by taking one sample during each radar-return pulse, but since the method is not restricted to that type of data this report presents some possible extensions. Specifically it is assumed that more than one data sample may be extracted from each backscattered pulse from the target, and the covariance function, the PSD function, the finite Fourier transform, and conjugate transform are applied.

6002 Final Technical Summary Report-Part I on SRI Project 3857, "Research on Ballistic Missile Defense Phenomenology," C. Flammer, editor, SD-103, ARPA Order 281-62, Dec 63, (82:35), Unclassified, AD 429 547.

This report summarizes the progress on work concerned with phenomena related to the design of ballistic-missile defense systems; it covers a 14-month period ending 30 November 1963. It contains abstracts of technical reports previously issued during the period, and some work, not previously presented, is given in greater detail. The subject matter covered in Part I includes: (1) mathematical analysis of nonstationary stochastic processes; (2) studies of electromagnetic interactions with ionized media (5 pages only); (3) theoretical studies of interactions of moving bodies with the ionosphere, precursor effects

STANFORD RESEARCH INSTITUTE (CONT.)

6002 (Cont.)

in electromagnetic shock tubes, and problems associated with the detection of signals immersed in nonstationary noise; and (4) collisional ionization and chemi-ionization experimental studies. There is a 34-page theoretical treatment of ion and electron distributions behind a body moving in the ionosphere.

6003 Technical Report 22 on SRI Project 3857, "A Survey of Methods for Treating Electromagnetic Scattering By Re-entry Wakes," G. H. Keitel, SD-103, ARPA Order 281-62, Jun 64, (89:57), Unclassified, AD 445 729.

Electromagnetic scattering by axially-uniform cylindrical columns of ionization is examined for homogeneous, Gaussian, and parabolic radial electron distributions (and for the limiting case, the metallic cylinder) for both normal and off-normal incidence. The effect of turbulence in the underdense column is considered and related to the autocorrelation (or spectrum) of the turbulence; in the overdense column, it is approximated by a roughness on an "equivalent metallic cylinder," which permits the estimation of that component of the radar cross-section. A relationship is developed between the circular scattering coefficient of an infinite cylinder and the cross-section of an axially-varying cylinder. This analysis is applied to certain typical re-entry wakes, resulting in estimated curves of cross-sections as a function of frequency, aspect angle, and assumed models. Appendices treat several theoretical topics relating to the subject: the wave-matching technique; the Born approximation; the relationship between cross-section and the cylindrical scattering coefficient; and scattering by rough metal surfaces.

6004 Scientific Report 1 on SRI Project 3947 (AFCRL-62-873), "Comparisons of Time Integrated Radar Detected Precipitation with Satellite Observed Cloud Patterns," R. E. Nagle, AF 19(628)-284, Jul 62, (56:23), Unclassified, AD 287 584.

In this report, numerous integrated radar-echo patterns and TIROS I television cloud pictures are compared in an attempt to ascertain if precipitating clouds can be distinguished from non-precipitating clouds in the satellite pictures. Nine different cases are presented, showing precipitation-to-cloud relationships in varying synoptic situations and in different climatic regions of the world. About the only radar-reflectivity information in this report is concerned with the unusually high reflectivity values which are attributed to large hail in the observed storm cores. The coarseness of the data renders the results somewhat inconclusive.

6005 Semiannual Technical Report III on SRI Project 4090, "Measurements and Specifications for the Project Dazzle Radar," J. Schlobohm, R. Todd, and R. Winkelman, DA 04-200 ORD-1268, 10 Jan 64, (127:0), Unclassified, AD 434 857.

This report describes the individual subsystems that comprise the Project Dazzle radar, and measurements made on the radar during checkout. The radar was designed to provide detailed measurements of re-entry wakes at frequencies of 55 and 153 Mc. It will make use of the amplitude and phase of the returned signals to determine the size and shape of the wake and of individual blobs of ionization in the wake, and the rate of motion of the wake and of its component blobs.

STANFORD RESEARCH INSTITUTE (CONT.)

6006 Technical Report 1 on SRI Project 4172, "Comparison of Precipitation and Tropospheric Scattering Cross-Sections," F. G. Fernald and A. S. Dennis, DA 36-039 SC-90859, Jan 64, (24:19), Unclassified, AD 434 836.

This report provides a means of identifying cases where precipitation scatter predominates on tropospheric scatter links. Scattering cross-sections of gaseous components of the atmosphere and of precipitation particles are derived as functions of path length, beamwidth, frequency, and weather conditions. Results for the case with both antennas directed at the horizon and uniform precipitation in the common beam volume are summarized on a nomogram for ease in comparing the scattering cross-sections. An outline of the procedure for using the nomogram is followed by an example. It is pointed out that attenuation due to precipitation is unimportant below 10 Gc except for heavy precipitation and even that can be ignored below 1 Gc.

STANFORD UNIVERSITY, STANFORD ELECTRONICS LABORATORIES

6007 Technical Report 1 (AFOSR-TN-57-466), "Reflection and Transmission at a Sharply-Bounded Ionosphere," I. W. Yabroff, AF 18(603)-126, 29 Jul 57, (70:15), Unclasssified, AD 136 457.

Development of equations which define the electromagnetic fields on either side of the boundary of a sharply-bounded homogeneous ionosphere, starting from Maxwell's equations. Expressions are derived for the reflection coefficients, wave normal directions, ray directions, and phase velocity. Reflection coefficients are expressed without restriction as to frequency or angle of incidence. Variation of reflection coefficient between E-W and N-S transmissions is calculated for VLF cases and found to be negligible. Transmission-line equivalent circuits of the ionosphere are derived for vertical and oblique incidence.

6008 Scientific Report 4 (AFCRC-TN-59-202), "Reduction and Processing of F-Layer Propagation Data," P. M. LaTourrette, AF 19(604)-1830, 15 Dec 58, (68:15), Unclassified, AD 230 682.

HF F-layer maximum usable frequencies (MUF) predicted by Central Radio Propagation Laboratory (NBS) are compared with experimental backscatter records obtained by Stanford. Initial parts of the report contain background information on basic techniques of HF propagation and prediction procedures by backscattering. A number of graphs showing measured and predicted data are in the form of MUF and equivalent path length vs. time; in general, agreement is shown to be good.

6009 Final Report (SEL-63-127), "The Effects of the Aurora on Radio-Wave Propagation," A. M. Peterson, AF 19(604)-1830, Oct 63, (58:49), Unclassified, AD 429 048.

This report, which summarizes the forward-scattering and backscattering of radio waves by the aurora, includes a study of the characteristics of field-aligned ionization irregularities. Following a brief discussion of past auroral observations, the geometry of radar reflections from the aurora is discussed in detail. It is pointed out that strong echoes are seen only when the ray from the transmitter to the auroral ionization meets the earth's magnetic-field line at or near perpendicular incidence. Departures from the perpendicular increase with decreasing frequency, reaching about 15° for frequencies near 100 Mc. Loci of points of perpendicular-reflection contours for a succession

6009 (Cont.)

of heights are presented for several radar sites. Maps are also presented which show optical and radar auroral zones at 100- and 200-km assumed heights of reflections.

A study of auroral scatter propagation of 64 to 106 Mc signals disclosed pulse-by-pulse amplitude and phase variations which seem to indicate that the signals are scattered from many small scattering regions distributed in space. Long-range auroral echoes are attributed to "tilt mode" propagation, which results from a decreasing gradient of electron density that permits reflection at the F-layer. It is suggested that long-range returns result from ground back-scattering after two or more reflections from the F-layer without intervening ground reflections.

6010 Scientific Report 1 (AFCRC-TN-58-635), "Radio Reflections from Artificially Produced Electron Clouds: Smokepuff II," P. B. Gallagher and O. G. Villard, Jr., AF 19(604)-2075, 15 Dec 58, (38:0), Unclassified, AD 230 690.

Chemically seeded ion clouds in the E-region of the ionosphere were detected using ionospheric radars. Discrete radar echoes in the HF and VHF range were observed for up to 2 hours following the successful release of the chemicals from an Aerobee rocket at approximately 118 km altitude. Radar data indicated that approximately 10^{20} electrons were produced, yielding critical frequencies above 23 Mc for about 30 seconds. Analyses of radar records suggest that within several minutes after release, the ionic cloud assumed roughly the proportions of a horizontally disposed prolate spheroid many hundreds of meters in diameter. Splitting of the cloud and subsequent drift motion were also observed during the early stages of its existence. During this period, critical frequencies remained between 6 and 8 Mc, sufficient to support normal communication in the upper portion of the HF band.

6011 Scientific Report 4 (AFCRC-TN-58-370), "Meteor Scatter," V. R. Eshleman, AF 19(604)-2193, Aug 58, (36:60), Unclassified, AD 160 819.

Reviews and extended studies of the mechanism of radio scattering from meteor trails under all combinations of low and high electron line density, long and short wavelength, and back- and forward-scattering. Number distributions of echo amplitudes and durations are considered, along with diurnal and seasonal variations in the number and directions of arrival of meteors. Information on echo characteristics and meteor rate and radiant variation was used to study the total fluctuating signal propagated over various paths by means of scattering from numerous meteor ionization trails. Theoretical characteristics of meteor echoes from low- and high-density trails at long and short wavelengths are tabulated; these include echo intensity, duration, and average and median power levels. An extensive bibliography is included.

6012 Scientific Report 5 (AFCRC-TN-59-381), "Theory of Radar Studies of the Cislunar Medium," V. R. Eshleman, R. C. Barthle, and P. B. Gallagher, AF 19(604)-2193, 8 Jul 59, (20:13), Unclassified, AD 220 389.

Presentation of several feasible techniques for using HF radar echoes from the moon in order to determine the integrated ion density between the earth and moon, a distance of about 60 earth radii. Limitations and relative feasibilities of pulse and modulated-CW techniques, and the effects of lunar characteristics, primarily surface roughness, are discussed.

STANFORD UNIVERSITY, STANFORD ELECTRONICS LABORATORIES (CONT.)

6013 Scientific Report 6 (AFCRC-TN-60-135), "Radar Echoes from the Sun," V. R. Eshleman, R. C. Barthle, and P. B. Gallagher, AF 19(604)-2193, 11 Jan 60, (11:6), Unclassified, AD 231 814.

Radar echoes from the sun were obtained in April 1959, at 25.6 Mc with a 40-kw transmitter using a 4-rhombic antenna for both transmission and reception. Thirty-second pulses were transmitted in 15-minute trains. Received data were recorded for later analysis on a digital computer. Echoes were approximately 40-50 dB below the noise level after detection, but from post-detection integration the presence of echoes was demonstrated with chances for error on each day of less than 1 in 105.

6014 Scientific Report 7 (AFCRC-TN-60-363), "Radar Measurements of Meteor Activity with Applications to Communications," R. F. Mlodnosky, AF 19(604)-2193, 18 Apr 60, (169:30), Unclassified, AD 236 340.

Communication via meteor trails is highly directional because of the directivity of the scattering from the trails and the spatial distribution of trail orientations. This report presents the results of two years of radar measurements of meteor trails. Included are: (1) new experimental results on radiant distributions; (2) a theoretical explanation of features of the radiant distribution; (3) refinements in a technique of using backscatter measurements to determine directional characteristics of forward-scatter, meteor-propagated communication; and (4) predictions of diurnal and seasonal variations in propagation characteristics of meteor-scatter communication systems. The work does not deal directly with the reflectivity properties of meteors, but rather is concerned with the relative angular bearings that will optimize the meteor-scatter duty cycle.

6015 Scientific Report 8 (AFCRL-TN-60-779), "Some Properties of Radio Waves Reflected from the Moon and Their Relation to the Lunar Surface," T. Hagfors, AF 19(604)-2193, 8 Aug 60, (26:12), Unclassified, AD 241 719.

A theoretical discussion of the statistical properties of radio waves reflected from the moon, based on the assumption that a large number of scattering areas simultaneously contribute to the signal. Echo properties are usually described in terms of pulse broadening or (for very short pulses) by an average-power pulse response. It is shown that the same information may be obtained from the correlation of the complex amplitudes of two sine waves reflected from the moon at frequencies separated by $\Delta\omega$. From this correlation as a function of $\Delta\omega$, the power pulse response of the earth-moon-earth propagation circuit can be computed. This method should prove particularly useful in studying the surface properties of the planets. It is also shown how the correlation technique can be extended to a two-dimensional mapping of a rotating rough body. Properties of lunar echoes are related to a crude statistical model of lunar surface roughness. This model satisfactorily accounts for the semi-specular return from the moon if a large-scale structure with rms slopes of 1/20 to 1/10 is assumed, but does not account for the tail of the echoes which presumably is caused by small-scale features superimposed on the large-scale structure.

6016 Scientific Report 9 (AFCRL-TN-60-969), "The Detection of Radar Echoes from the Sun," R. C. Barthle, AF 19(604)-2193, 24 Aug 60, (52:13), Unclassified, AD 243 867.

6016 (Cont.)

Discussion of equipment and data reduction involved in obtaining a radar echo from the sun. Attention is given to the effect of background noise and pulse length, to the sun as a radar target, and to adjacent-channel noise-amplitude correlation. Procedures and results are given for trials conducted in April and September 1959. Favorable output from these trials yielded valuable information for suggesting future solar and planetary radar-echo experiments.

6017 Final Report (AFCRL-127), "Meteor Rate and Radiant Studies," AF 19(604)-2193, 30 Dec 60, (41:16), Unclassified, AD 253 252.

Briefly summarizes research conducted from March 1957 through November 1960. Included are abstracts of eleven scientific reports prepared during this period. Much of the document describes facilities of the Radiosciences Laboratory at Stanford Electronics Laboratory. Abstracts of Scientific Reports 1-11 give brief summaries of the studies (see preceding abstracts). Important reflectivity results pertain to sun and moon echoes at HF (about 28 Mc). Moon echoes were used to determine parameters such as the effects of retardation, dispersion, and roughness of the ionosphere on pulsed and CW echoes from the moon. The equivalence of pulse and CW methods for studying the features of a rough moon was investigated theoretically. Reflections from the sun's corona are also discussed.

6018 Final Report (SEL-62-064; AFCRL-62-188), "Bibliography of the Ionosphere. An Annotated Survey through 1960," L. A. Manning, AF 19(604)-6194, May 62, (613:≈4000), Unclassified, AD 277 749.

List of most papers on the ionosphere published in recognized journals through 1960. The period covered goes back to the important pioneer studies of 1925, and in some cases to earlier work. Articles in symposium volumes, books, or technical reports are not included. Papers included deal with ionospheric radio propagation, radio studies of the ionosphere, and physics of the ionosphere important to radio studies. Examples of topics are: radio studies of the aurora, rocket studies of the upper atmosphere, eclipse effects on radio propagation, recombination and diffusion processes in the F region, solar effects on the ionosphere, and the formation of ionized meteor trails. While primary interest was not in radar studies, a number of references on the subject are included in the nearly 4000 papers listed.

6019 Scientific Report 2 (AFCRL-739), "Calculations of Signal-to-Noise Ratios for Solar Radar Echoes," P. Yoh, AF 19(604)-7436, 18 Jul 61, (25:13), Unclassified, AD 265 347.

A procedure for computing the signal-to-noise ratio of radar echoes from the sun. Radial distribution of electron density in the corona, the coronal temperature, solar noise, galactic noise, and system parameters are considered. The Stanford and Lincoln Laboratory solar radars are used as examples of the computation method. Potential results from the echoes will yield information regarding corona rotation rates, coronal structure, absorption characteristics, and effects of solar magnetic fields.

6020 Scientific Report 4 (SEL-62-027; AFCRL-62-88), "Scattering of Radiation by the Fluctuations in a Non-Equilibrium Plasma," O. Buneman, AF 19(604)-7436, Feb 62, (10:8), Unclassified, AD 273 649.

STANFORD UNIVERSITY, STANFORD ELECTRONICS LABORATORIES (CONT.)

6020 (Cont.)

Theoretically derived expressions are used to calculate total scattered power as a function of wavelength and various electron-to-ion temperature ratios. The backscattered power spectrum is determined as a function of the above ratios as well as interaction factors between the electrons and ions.

Note: Scientific Report 5 (SEL-62-062; AFCRL-62-192) is entitled "On the Velocity Distribution of Sporadic Meteors," Unclassified, AD 276 679.

6021 Scientific Report 6 on AF 19(604)-7436 and Scientific Report 3 on AF 19(628)-233 (SEL-63-066; AFCRL-63-807), "On the Power Scattered from Density Fluctuations in a Plasma," D. R. Moorcroft, AF 19(604)-7436 and AF 19(628)-233, Jun 63, (5:4), Unclassified, AD 418 305.

The power spectral density for scattering from density fluctuations in a plasma was numerically integrated to check an approximate analytical expression for the total scattered power. For all ratios of wavelength to Debye length, the analytical expression decreases monotonically with increasing ratio of electron temperature to ion temperature. The numerical results differ significantly from this behavior only for temperature ratios greater than about two, where they fall to a minimum and then rise to a maximum for large temperature ratios.

6022 Scientific Report 1 on NsG-377 and Scientific Report 7 on AF 19(604)-7436 (SEL-63-125; AFCRL-63-798), "On the Determination of Temperature and Ionic Composition by Electron Backscattering from the Ionosphere and Magnetosphere," D. R. Moorcroft, AF 19(604)-7436 and NASA Grant NsG-377, Oct 63, (32:11), Unclassified, AD 428 954.

Observations of the scattering of electromagnetic waves from thermal fluctuations in the electron density of the ionosphere and magnetosphere have previously been used to investigate ion and electron temperatures and electron density, under the assumptions that only O^+ ions are present, and that $4\pi D/\lambda \ll 1$, where D is the Debye length; these conditions obtain at F-layer heights. This report extends that work to conditions likely to prevail above the F region, where increasing percentages of He^+ and H^+ are expected to occur, and where $4\pi D/\lambda$ may not be very small. It appears that a powerful radar at low frequency could be used to determine the relative concentrations of the constituent ions as well as electron and ion temperatures and electron density. The results can be used for values of $4\pi D/\lambda$ up to unity.

6023 Final Report (SU-SEL-64-114), "Radar Astronomy and Propagation Research," H. T. Howard, B. B. Lusignan, and V. R. Eshleman, AF 19(604)-7436, Sep 64, (44:29), Unclassified, AD 453 029.

This report summarizes the results of research conducted during a four-year period on the use of radar-astronomy techniques in studying the solar corona, interplanetary gas density, ionospheric electron content, and cislunar gas density. Abstracts of eight scientific reports prepared during the report period are included. Monostatic radar echoes from the sun were obtained at 26 and 38 Mc; solar cross-sections as well as range Doppler spectra are cited.

STANFORD UNIVERSITY, STANFORD ELECTRONICS LABORATORIES (CONT.)

6024 Scientific Report 2; Technical Report 1403-3 (SEL-63-041; AFCRL-62-1122), "Detection of Solar Particle Streams Using High-Frequency Radio Waves," B. B. Lusignan, AF 19(604)-7994, Apr 63, (34:9), Unclassified, AD 406 839.

Interactions between radiowaves and charged particles of high average velocity are investigated assuming no collisions, no external magnetic field, and low particle densities. A stream of such particles makes the medium anisotropic. As a result the medium propagates two waves of unchanging polarization, one linearly polarized perpendicular to the particle stream and a second at right angles to the first. Such a medium can change the polarization ellipse of a propagating wave. The sun produces such streams radiating outward either in the form of a steady "solar wind" or in bursts associated with sun spots. Three experiments are suggested to detect the streams by measuring polarization of waves propagated through them. The least sensitive of the three, moon radar, would have measurable effects only during increased solar activity, while the other two--transmission to a deep space probe and observation of polarized cosmic noise sources--show effects even during quiet solar conditions. These sensitivities are based on observations of the proton component of the solar wind.

6025 Final Report (SU-SEL-64-123; AFCRL-64-922), "The Effects of the Aurora on Radio Wave Propagation," A. M. Peterson, AF 19(604)-7994, Oct 64, (49:70), Unclassified, AD 455 004.

This report summarizes research at Stanford University on the effects of aurora on radio-wave propagation. Abstracts are included of work reported in detail in other reports. Also included is a detailed theoretical study not reported elsewhere of the generation of synchrotron noise by auroral electrons spiralling in the earth's magnetic field.

6026 Technical Report 770-3, "On the Scattering of Electromagnetic Waves by Nonisotropic Inhomogeneities in the Atmosphere," D. T. Gjessing, DA 36-039 SC-78296, 10 May 61, (21:13), Unclassified, AD 259 541.

Theoretical discussion of the scattering of radio waves by a non-isotropic permittivity field. The problem is generalized to non-isotropic atmospheric conditions with axes of symmetry which are neither vertical nor horizontal. A simple expression for the scattering cross-section is derived working in Fourier space; on the basis of this discussion some observed anomalies of long-distance communications in the troposphere can be explained.

6027 Technical Report 2270-4 (SEL-63-060), "Reflection of Radio Waves from Undulating Tropospheric Layers," A. T. Waterman, Jr. and J. W. Strohbehn, DA 36-039 SC-87300, May 63, (22:12), Unclassified, AD 420 414.

This report examines the nature of coherent reflections of radio waves at near-grazing incidence from a horizontal atmosphere layer on which is superimposed a slight wave motion. Such reflections are merely postulated as being possibly observable in transhorizon propagation experiments. The properties of angle of arrival, signal level, fading, and Doppler shift are examined, together with their rates of change with time.

6028 Technical Report 73, "The Scattering Cross Section of a Row of Circular Cylinders," T. T. Wu and H. Levine, Nonr-225(11), 26 Mar 58, (37:7), Unclassified, AD 162 710.

STANFORD UNIVERSITY, STANFORD ELECTRONICS LABORATORIES (CONT.)

6028 (Cont.)

A plane electromagnetic wave is incident on a row of N infinitely long cylinders with spacing b and radius a. The direction of incidence is along the row, such that only one cylinder is illuminated in the sense of optics. The total scattering cross-section $\sigma_N(\lambda)$ is calculated for $a/\lambda \gg 1$. The result is:

$$\frac{\sigma_N(\lambda)}{4a} = 1 + \frac{1}{2\sqrt{\pi}} \frac{(kb)^{\frac{1}{2}}}{ka} [1 + 2^{-\frac{1}{2}} + \ldots + (N-1)^{-\frac{1}{2}}] + A(ka)^{-2/3}$$

$$+ B(ka)^{-1/3} (kb)^{-\frac{1}{2}} [1 + 2^{-3/2} + \ldots + (N-1)^{-3/2}] + O(k^{-7/6}) \quad .$$

With the electric vector parallel to the cylinder axes,

$A = 0.49807659$ and $B = -0.03321963$.

With the magnetic vector parallel to the cylinder axes,

$A = -0.43211998$ and $B = -0.19873959$.

These formulas should retain their validity when the cylinders are connected by flat sheeting of thickness less than 2a, and also when $b \leq 2a$ and the cylinders interpenetrate.

6029 Technical Report 24, "Motion of Sporadic-E Patches Determined from High Frequency Backscatter Records," C. Clark, Nonr-225(24), 18 Sep 57, (106:53), Unclassified, AD 143 606.

Description of the use of ionospheric sounding equipment to measure the characteristics of 2700 patches of sporadic-E (E_s). Speed and direction distributions are presented as well as geographic, diurnal, and seasonal information. Evidence is presented rejecting E_s formation and motion by thunderstorms or electromagnetic radiation and attributing them to turbulence and winds.

6030 Technical Report 50, "Air Motions and the Fading, Diversity, and Aspect Sensitivity of Meteoric Echoes," L. A. Manning, Nonr-225(24), 10 Dec 58, (29:14), Unclassified, AD 211 624.

This report comprises a well-written qualitative description of a theory concerning radio reflections from meteor trails. This theory investigates the effect which distortion of the (initially straight) form of a meteor trail by wind shear will have on the reflected signal. It assumes horizontal stratification and Gaussian distribution of the components of the velocity profile, and explains various observed features in detail. The theory supposes that after the wind has given the trail a serpentine form, the total reflection can be approximated by that from a series of glint points, each comprising the first Fresnel zone of reflection centered on a point where the trail is normal to the direction of propagation. It is shown how the number of such points will

STANFORD UNIVERSITY, STANFORD ELECTRONICS LABORATORIES (CONT.)

6030 (Cont.)

gradually increase as the distortion of the trail progresses, and how each point will divide into two shortly after formation. The consequences of such a scattering system are explored qualitatively, and related to a number of well-known but heretofore not explained features of meteoric return. These features include the delay in the start of echo fading, the delay in echo appearance with aspect, the spectral composition of the received signal, the regularity of the fading pattern, and the correlation of fading patterns at two ground receivers.

6031 Technical Report 1150-1 (SEL-62-137), "The Theoretical Heights and Durations of Echoes from Large Meteors," L. A. Manning, Nonr-225(24), Nov 62, (23:6), Unclassified, AD 441 211.

A detailed theoretical development of mathematical theory concerning the durations of radio echoes from overdense trails (i.e., those for which electron line density is appreciably greater than 10^{14} per meter). The dependence of the height distribution of ionization on meteor magnitude, velocity, zenith angle, and other parameters is examined, taking account of two-, three-, and m-body attachment processes. It is shown that well-defined attachment-free and attachment-controlled duration regions exist with different line-density and wavelength dependences. The transition zone is broad, and its location depends strongly on meteor velocity. Meteor echoes are found to fall into three groups, each having a characteristic duration behavior: (1) underdense; (2) overdense without electron loss; and (3) overdense with attachment.

6032 Technical Report 4, "Abstracts of Articles on Ground Backscatter Propagated by the Ionosphere," A. K. Brown, Nonr-225(33), 28 Jul 59, (20:70), Unclassified, AD 227 925L. (All requests through ONR Code 418.)

This document contains a collection of 70 short, informal abstracts on ionospherically propagated ground backscatter, selected from the published literature. A majority of the articles are from the Proceedings and Transactions of the IRE, the Journal of the Institution of Electrical Engineers, and Nature.

6033 Technical Report 5, "A Technique for Displaying the Time Variation of the Spectral Distribution of the Fading Fluctuations and Doppler Shifts of Ionospherically-Propagated Ground Backscatter in Selected Small Range Intervals," P. W. Carlin, Nonr-225(33), 31 Jul 59, (30:1), Unclassified, AD 227 926L. (All requests require approval of Office of Naval Research, Washington 25, D. C., Attn: Code 418.)

A 12-30 Mc backscatter sounder is described; 15 pages of photographs show backscatter frequency-amplitude time displays.

6034 Technical Report 13, "On the Doppler Shifts of Standard-Frequency Signals Transmitted Via the Ionosphere," R. C. Fenwick, Nonr-225(33), Jun 60, (-:12), Unclassified.

(BD-795) Doppler shift patterns are shown to be of three principal types, designated normal, presumably one-hop (near MUF), and disturbed. Probable correlations between WWV Doppler shift and fluctuations in the earth's magnetic field are described. Propagation modes are identified by reference to radar backscatter records, and probable correlation between backscatter and WWV Doppler shifts is indicated.

STANFORD UNIVERSITY, STANFORD ELECTRONICS LABORATORIES (CONT.)

6035 Technical Report 17, "Some Characteristics of Multiple-Hop Sweep-Frequency Backscatter Observations Between 15 and 54 Mc/s," L. P. Bolgiano, Jr., Nonr-225(33), 10 Oct 60, (25:1), Unclassified, AD 245 844L. (All requests require approval of Office of Naval Research, Washington 25, D. C., Attn: Code 418.)

Description of some sweep-frequency backscatter measurements between 15 and 54 Mc. The report is mainly descriptive; seventeen pages of photographs are included.

6036 Technical Report 24, "An HF-Radar Search for the Effects of Earth Satellites Upon the Ionosphere," T. A. Croft, Nonr-225(33), ARPA Order 32, 10 Mar 61, (65:-), Unclassified.

(BD-8831) In a search for ionospheric effects of artificial earth satellites, records of ionospherically reflected ground backscatter were obtained with HF radar equipment and directive antennas during times of satellite passage. A series of 139 such observations were conducted beginning in August 1959. Most were made during passages of Sputnik III and some with Echo I. Each record was analyzed for the presence of a direct reflection from the area of the satellite or of any unusual ionospheric irregularity as manifested by a change in ground backscatter. On six occasions the radar sensitivity was such that an object one order of magnitude larger than the satellite should have been just detectable; in no case was a direct reflection actually observed. Numerous suggestive anomalies in ground backscatter were seen; however, no conclusive causal relationship between the satellite and the anomaly could be demonstrated.

6037 Technical Report 34, "Observation of Large-Scale Traveling Ionospheric Disturbances by Spaced-Path, H-F, Instantaneous-Frequency Measurements," K. L. Chan and O. G. Villard, Jr., Nonr-225(33), ARPA Order 196-61, 9 Nov 61, (-:26), Unclassified.

(BD-2691) The instantaneous frequency of WWV at 20 Mc from Washington, D. C., and that of a highly stable signal at 17.8 Mc from Mayaguez, Puerto Rico, were simultaneously and continuously recorded between October 1960 and September 1961 at Palo Alto, Calif. and at Seattle, Wash. Traveling ionospheric disturbances (TID's) have been identified on these recordings by noting the occurrence of similar frequency fluctuations appearing with appropriate time delays, and in the appropriate order, on each of the four available paths. The geometry of these paths is such that disturbances traveling from north to south, or vice-versa, are most easily detected. In this report, TID's in the F_2 layer in a non-auroral region are investigated by observing their effect on the instantaneous received frequency of four stable HF transmissions.

6038 Technical Report 37 (SEL-62-004), "Use of a Phase-Sensitive Backscatter Sounder to Deduce Ionospheric Changes Associated With a Solar Flare," G. Barry and P. Widess, Nonr-225(33), ARPA Order 196-61, 12 Dec 61, (-:5), Unclassified.

(BD-2769) Ionospheric effects of a solar flare on 1 December 1959 were observed at Stanford with a 25-Mc fixed-azimuth backscatter radar. The equipment measured amplitude and frequency shift of the backscattered signal. The general characteristics of the disturbance resemble those measured with forward-propagated signals during SID's--i.e., a sudden initial increase in frequency lasting for a short period of time, followed by attenuation and virtual

STANFORD UNIVERSITY, STANFORD ELECTRONICS LABORATORIES (CONT.)

6038 (Cont.)

disappearance of the backscatter. From the measured frequency shift of the ground backscatter as a function of range, and from other considerations, a model of the ionospheric changes caused by the flare is constructed.

6039 Technical Report 58 (SEL-62-148), "Some Characteristics of the Spatial Distribution of Received Field Strength in Multihop HF Propagation," J. Ames, Nonr-225(33), ARPA Order 196-62, Dec 62, (-:2), Unclassified.

(BD-3959) The spatial properties of the interference pattern that produces fading on HF signals propagated over a long path were observed using a non-phase-sensitive, L-shaped array of antennas about 20λ on a side. During periods of regular fading straight, parallel nulls are observed to move across the ground primarily at angles of about 45° with respect to the great-circle path. A tentative theory shows how these nulls could be formed by interference between waves whose sources are the last two ionospheric reflection points of a multihop HF path. This theory suggests that spatial fading measurements might be useful in measuring small-scale tilts in the ionosphere transverse to the direction of propagation. Measurements described in this report are basic to the design of space-diversity receiving systems.

6040 Technical Report 72 (SEL-63-011), "Some Backscatter, Sweep-Frequency Observations," S. N. Denno and O. G. Villard, Jr., Nonr-225(64), Feb 63, (65:18), Unclassified, AD 402 964.

Ray theory is used to analyze echoes from a swept-frequency ground-backscatter system operating at HF; characteristics of the backscatter echo are studied with emphasis on group-path and time-delay effects. Continuous soundings eastward and westward from Stanford are described and layer models are discussed. Variation of the time delay of an echo is studied by calculating the equivalent group path and by tracing the actual group path with an analog computer. In analyzing the experimental data, striations appearing in the soundings are emphasized. Causes and effects are discussed, with particular attention to the effects of E- and F-layer irregularities and ground objects.

6041 Technical Report 76 (SEL-63-062), "A Test of the Reality and Practical Importance of Ionosphere-Ionosphere Reflections in Long-Distance HF Propagation," R. C. Fenwick and O. G. Villard, Jr., Nonr-225(64), ARPA Order 196-62, May 63, (-:3), Unclassified.

(BD-4979) This report describes a test of the reality and practical importance of long-distance HF propagation in which multiple successive reflections from the F-layer take place. Such modes are launched and recovered by appropriate tilts. Westbound transmissions at various frequencies were launched from Okinawa and received in the Mediterranean area and on the island of Guam. It is shown that at times when the Okinawa signals were inaudible in Europe, they were readily audible at Guam via the long path over a comparatively wide band of frequencies. This result was predicted on the basis of the magnitude and location of F-layer tilts present at the time. Since there is strong evidence that the Okinawa-Guam long-path signals followed the great circle, it is concluded that they must have passed over the European receiving sites while propagating along the underside of the F-layer in a tilt-supported mode. This result supports the hypothesis that round-the-world propagation involves earth-ionosphere reflections in the daylight hemisphere, and ionosphere-ionosphere reflections in the dark hemisphere.

STANFORD UNIVERSITY, STANFORD ELECTRONICS LABORATORIES (CONT.)

6042 "Bibliography of Technical Reports Issued by Stanford Electronics Laboratories During 1959," [1959], (7:86), Unclassified, AD 609 073.

Listing of 86 reports issued during 1959, including author, title, report number, contract, date, and classification. Entries are arranged by subject categories; about twenty reports are especially pertinent. An author index is included.

6043 "Abstracts of Unclassified Technical Reports Issued by Stanford Electronics Laboratories During 1959," [1959], (31:59), Unclassified, AD 609 074.

Abstracts for 59 unclassified reports issued in 1959 are arranged according to contract; a few are pertinent to radar reflectivity.

6044 "Bibliography of Technical Reports Issued by Stanford Electronics Laboratories During 1960," [1960], (7:107), Unclassified, AD 609 027.

List of 107 reports issued during 1960, arranged by subject categories. Some entries under "Radioscience:Ionosphere Studies, and Antennas" are pertinent; information given includes author, title, report number, date, and classification. An author index is included.

6045 "Bibliography of Technical Reports Issued by Stanford Electronics Laboratories, 1949 through 1958," [1958], (19:300+), Unclassified, AD 609 082.

Listing of over 300 reports, arranged by subject categories and showing author, title, report number, contract, date, classification, and availability. Many reports pertain to radar reflectivity but early publication dates somewhat limit their usefulness. An author index is included.

6046 "Abstracts of Unclassified Technical Reports Issued by Stanford Electronics Laboratories, 1949 through 1958," [1958], (105:300+), Unclassified, AD 609 075.

Abstracts of more than 300 unclassified reports issued between 1949 and 1958 are arranged according to contracts. Although a few reports are pertinent to radar reflectivity, their early dates lessen their value.

STEVENS INSTITUTE OF TECHNOLOGY

6047 Technical Report 2 (SIT P-18), "The Shift of the Shadow Boundary and the Scattering Cross Section of an Opaque Object," S. I. Rubinow and J. B. Keller, Nonr-263(30), Sep 60, (20:6), Unclassified, AD 245 408.

When radiation of wavelength λ is incident on an opaque object of typical dimension a, and λ/a is small but not zero, the shadow boundary is shifted slightly from the geometrical shadow boundary that prevails in the limit $\lambda/a = 0$. Because of disagreements in previous work, the shift was recalculated for the circular cylinder and found to be the same as determined by S. O. Rice (Bell Sys. Tech. J. 33, 417 (1954)) for parabolic cylinders. The resulting value of shift is $\alpha(\lambda^2 a)^{1/3}$, where the constant α depends upon the impedance of the object at the point of tangency. This result is thought to hold with any two- or three-dimensional object when λ/a is small. Also determined is the cross-section per unit length of a circular cylinder for λ/a small and for an

STEVENS INSTITUTE OF TECHNOLOGY (CONT.)

6047 (Cont.)

impedance boundary condition. The deviation from the geometrical-optics cross-section is proportional to the boundary shift. The calculations are done for the scalar case and the corresponding electromagnetic case is considered separately.

SYLVANIA ELECTRIC PRODUCTS, INC., ELECTRONIC DEFENSE LABORATORIES

6048 Engineering Report EDL-E26, "On Scattering of Waves by a Slab Region of Randomly Distributed Objects," V. Twersky, DA 36-039 SC-75012, 1 Jan 58, (67:27), Unclassified, AD 161 276.

A plane electromagnetic wave is incident on a "uniformly random" distribution of scatterers in a volume between two parallel planes. Chief assumptions of the study are that the average separation of scatterers be large compared to their size, and that the scatterers have fixed orientation in space (although they may have "fairly arbitrary" shape). Expressions are obtained for the coherent transmitted, reflected, and internal fields, accounting for coherent multiple scattering by means of the ensemble average of the Green's function representation for the field of a fixed configuration of scatterers. Corresponding expressions are obtained for the differential scattering cross-section per unit volume (i.e., incoherent scattering), and for the differential scattering cross-section per unit area of face plane. Parameters of the final results are the average number of scatterers per unit volume, equivalent slab thickness, incidence angle and wavelength, and scattering amplitudes of the isolated elements.

6049 Engineering Report EDL-E28, "On Scattering of Waves by the Infinite Grating of Circular Cylinders," V. Twersky, DA 36-039 SC-75012, 1 Mar 58, (81:25), Unclassified, AD 200 298.

Previous work (see Abstract 6065) on scattering from a grating of relatively arbitrary elements is here specialized to the case of circular cylinders. There is obtained a set of algebraic equations which involve only the known scattering coefficients of an isolated cylinder and certain series of elementary functions. It is shown that the more complicated results obtained directly by separation of variables can be transformed to those obtained initially. As a check, the separation-of-variables method is extended to arbitrary angles and it is demonstrated that the results can be transformed to those obtained by the Green's function approach examined here. The equations are applied to obtain various closed-form approximations for both polarizations, for both conductors and dielectrics, and for all angles of incidence.

6050 Engineering Report EDL-E36, "On A New Scattering Formalism for the Macroscopic Electromagnetic Parameters," V. Twersky, DA 36-039 SC-78281, 7 Mar 59, (37:10), Unclassified, AD 219 639.

A new representation was obtained for the bulk parameters associated with the coherent multiple-scattered field arising when a plane wave excites a uniformly random distribution of relatively arbitrary objects. The parameters are expressed functionally in equations involving a new type of scattering amplitude for a single object; i.e., the amplitude corresponding to an object excited by a wave traveling in one space and then radiating into another space (an essentially new class of single-body scattering problems involving three sets of physical parameters: incident, internal, and scattered fields).

SYLVANIA ELECTRIC PRODUCTS, INC., ELECTRONIC DEFENSE LABORATORIES (CONT.)

6050 (Cont.)

Explicit results are given for distributions of small spheres having arbitrary constants, and for distributions of large tenuous scatterers of arbitrary shape.

6051 Engineering Report EDL-E37, "Scattering by Quasi-Periodic and Quasi-Random Distributions," V. Twersky, DA 36-039 SC-78281, 1 Apr 59, (46:11), Unclassified, AD 219 640.

This report concerns scattering of plane electromagnetic waves by arrays of parallel, coplanar, arbitrary cylinders distributed essentially as in a one-dimensional liquid of elastic objects. Green's function methods are used to generalize and extend earlier results obtained by separation of variables for circular cylinders (see Abstract 2396). A general form for the coherent field and a corresponding approximation for incoherent scattering are obtained with attention to coherent multiple scattering. A detailed description is given for the dependency of the field on scatterer separation in terms of generalized and asymtotic results.

6052 Engineering Report EDL-E44, "On Scattering of Waves by the Infinite Grating of Elliptic Cylinders," J. E. Burke and V. Twersky, DA 36-039 SC-78281, 2 Nov 59, (49:12), Unclassified, AD 236 667.

Previous work (see Abstracts 6065 and 6049) on scattering from a grating of relatively arbitrary elements is here specialized to the case of elliptic cylinders. The problem was specified in terms of an infinite set of linear algebraic equations involving the scattering coefficients of an isolated elliptic cylinder and certain special functions. These special functions were expressed in terms of Mathieu coefficients and Schlomilch series and then as series involving more elementary functions. Closed-form approximations were obtained for these conditions: major axis relatively small compared to wavelength, both electric and magnetic fields parallel to the elements, arbitrary angles of incidence, and arbitrary (as well as small) spacing (see also Abstract 6071).

6053 Engineering Report EDL-E45, "Mid-Field Forward Scattering," C. I. Beard, T. H. Kays, and V. Twersky, DA 36-039 SC-78281, 2 May 60, (81:10), Unclassified, AD 243 422.

Experimental and theoretical results are given for forward scattering by spheres with radii large compared to wavelength and with index of refraction near unity. Both intensity and phase of the scattered field relative to the incident field are measured and computed for several spheres as functions of the separations of transmitter and receiver from the scatterer. Actual measurements were made at 5 mm using styrofoam spheres. The measured forward scattering is in good agreement with the theoretical analysis.

6054 Engineering Report EDL-E46, "Forward Coherent and Incoherent Scattering from Random Volume Distributions of Spheres," C. I. Beard and V. Twersky, DA 36-039 SC-85402, 6 Jun 60, (80:16), Unclassified, AD 246 677.

The second in a series on joint experimental and theoretical investigations of multiple scattering by a large-scale dynamic model of compressible gas. This model comprised an assembly of styrofoam spheres (diameter 1.36 inches) in a styrofoam container and maintained in motion by turbulent air flow. The experimental program dealt with coherent and incoherent forward scattering at wavelengths near 5 mm. (For a detailed description of the millimeter

SYLVANIA ELECTRIC PRODUCTS, INC., ELECTRONIC DEFENSE LABORATORIES (CONT.)

6054 (Cont.)

scattering range, see Report EDL-M156, Abstract 6067). Scattered fields were measured primarily as functions of the number of spheres in the container. Concentrations ranging from 25 to 1800 spheres in a volume of 4800 cubic inches were investigated in steps of 100; these concentrations simulated the range from moderately rare gases up to very dense gases and near-liquids. Theoretical computations were based on the general theory for scattering by random distributions. Described also are innovations in the scattering range, experimental methods, and the statistical data-reducing procedure. The reduced data was compared with numerical computations based on theory; good accord was found over the full investigation range.

6055 Engineering Report EDL-E47, "Off-Forward Scattering from Random Volume Distributions of Spheres," C. I. Beard and V. Twersky, DA 36-039 SC-85402, 5 Jul 60, (57:9), Unclassified, AD 249 943.

Previous work (Report EDL-E46, preceding abstract) was continued with emphasis on investigation of the corresponding scattering effects as functions of the angle of observation. Five different simulated gas concentrations were investigated with the same model as before. For these concentrations, ratios of total scatterer volume to available volume were 0.0275, 0.050, 0.0963, 0.193, and 0.385. Angles of incidence ranged from 0° to 90°. Computations were based on theoretical expressions derived by a self-consistent procedure which assumes that each scatterer in the distribution is excited by the coherent field, but radiates into free space; in terms of such "schizoid" single-scatterers, dense distributions were treated essentially by the simple formalism that held for the space cases. Summarized are measurement data and scattered intensities as functions of the observation angle and of the concentration of the scatterers in the "gas container." Good agreement was obtained between experiment and theory for all cases.

6056 Engineering Report EDL-E48, "Diffraction by a Thick Screen, a Step, and Related Axially Symmetric Objects," J. E. Burke and J. B. Keller, DA 36-039 SC-78281, 1 Mar 60, (28:6), Unclassified, AD 239 717.

Geometrical theory of diffraction is applied to diffraction by a thick screen with a flat end which may be either a truncated cone or thick half-plane. The result is used to determine the field diffracted by a wave incident upon a surface containing a step. Other related geometries considered are: the semi-infinite circular cylinder with a flat end, the truncated circular cone, the junction between two parallel circular cylinders, and the junction between a truncated cone and a cylinder. A new diffraction coefficient is introduced, as well as a method for dealing with grazing-incidence waves.

6057 Engineering Report EDL-E49, "Diffraction by Finite Bodies of Revolution," J. E. Burke and J. B. Keller, DA 36-039 SC-78281, 4 Apr 60, (27:10), Unclassified, AD 239 718.

Fields scattered by a variety of finite bodies of revolution are constructed using the geometrical theory of diffraction. This theory specifies the scattered field as a superposition of fields of various rays. Some of these are specularly reflected from portions of the body having radii of curvature large compared to wavelength (the usual optical rays), and the remainder are diffracted rays. Multiple diffraction of an axially incident plane wave by

SYLVANIA ELECTRIC PRODUCTS, INC., ELECTRONIC DEFENSE LABORATORIES (CONT.)

6057 (Cont.)

curved edges of "hard" and "soft" finite cones (i.e., for boundary conditions that the normal derivative of the field, or the field itself, vanishes at the surface) is treated. Slight modification of the analysis and results produces corresponding fields for a finite circular cylinder, a cone backed by a finite circular cylinder, and a circular cylinder with a spherical nose. Fields on edge-diffracted rays for non-axial incidence, and on tip-diffracted rays, are also considered. Extension of such scalar results to vector electromagnetic problems is illustrated by considering diffraction by a circular edge of a perfect conductor.

6058 Engineering Report EDL-E41, "Design of Artificial Dielectrics with Predetermined Dispersion Characteristics," M. Matschke, DA 36-039 SC-85402, 24 Jun 60, (36:5), Unclassified, AD 241 347.

Description of a method of determining a dipole distribution function for a broadband quarter-wave plate to be fabricated from artificial dielectric. An artificial dielectric can be designed for a given application by specifying the required index of refraction, η, and solving the following integral equation for $\mu(f_o \nu_i)$:

$$\eta^2 - 1 = \int_0^\infty \frac{(\eta_o^2 - 1)\left(1 - \frac{\nu^2}{\nu_i^2}\right) \mu(f_o \nu_i)\, f_o\, d\nu_i}{\left(1 - \frac{\nu^2}{\nu_i^2}\right)^2 + g^2 \frac{\nu^2}{\nu_i^2}},$$

where $\nu = f/f_o$ and $\nu_i = f_i/f_o$,

f_o = arbitrary lower frequency limit,

f_i = resonant frequency of the dipoles,

$\mu(f_o \nu_i)$ = unknown dipole distribution function,

g = damping factor (assumed zero), and

η_o = zero-wavelength index of refraction.

The final form of the solution is, for $\nu \gg 1$,

$$D\mu(f_o \nu) = \frac{2\pi(C_1 \sqrt{2} + A^2) + 16A \log(2\nu)}{\pi f_o \nu},$$

where $D = \pi B/2$,

C_1 = arbitrary constant (determined experimentally),

$A = c/4df_o$, (c = velocity of light)

$B = \eta_o^2 - 1$, and

d = width of dielectric.

SYLVANIA ELECTRIC PRODUCTS, INC., ELECTRONIC DEFENSE LABORATORIES (CONT.)

6059 Engineering Report EDL-E58, "Elementary Results for High Frequency Scattering by Cones," J. E. Burke, L. Mower, and V. Twersky, DA 36-039 SC-87475, 24 Apr 61, (40:11), Unclassified, AD 268 393.

High-frequency scattering by finite cones is analyzed by approximating the surface fields in the integral representation with their geometrical-optics values. Both singly and doubly truncated cones were considered. It is shown that for many practical purposes a universal curve exists for the scattering pattern of a cone. This curve, which depends on a parameter involving cone length and half angle, falls more or less between the Fraunhofer aperture patterns for the strip and disk, and differs essentially in that the minima are not zero. Some numerical illustrations are included.

6060 Engineering Report EDL-E60, "On Scattering of Waves by Two Objects," V. Twersky, DA 36-039 SC-87475, 6 Mar 61, (31:21), Unclassified, AD 258 650.

Development of certain "self-consistent" sets of equations relating many-body scattering functions (such as multiple scattering amplitudes and multiple scattering coefficients) to their single-body analogs. The discussion begins by considering the surface-integral representations of the fields scattered by arbitrary objects and recasting these fields as continuous sets of plane waves multiplied by the required scattering amplitudes. Systems of integral equations relating the scattering amplitudes for multiple objects to corresponding functions for the isolated objects are obtained from the superposition principle without requiring explicit application of the boundary conditions. The scattering amplitudes are written as series of elementary angular functions times scattering coefficients, which leads to algebraic sets of equations obtainable by separation of variables. Using the integral equation for the scattering amplitudes, asymptotic representations are obtained for large separations. For arbitrary configurations, the system of differential equations describing the scattered amplitudes are developed as an asymptotic series of single scattered functions; closed forms involving differential operators were obtained for two objects.

6061 Engineering Report EDL-E61, "Multiple Scattering by Arbitrary Configurations In Three Dimensions," V. Twersky, DA 36-039 SC-87475, 1 May 61, (22:15), Unclassified, AD 259 945.

Extension of the theory developed in Report EDL-E60 (see preceding abstract), for multiple scattering of waves by arbitrary configurations of arbitrary scatterers in two dimensions, to include the three-dimensional case. A system of integral equations is derived in three dimensions which specifies the multiple-scattering amplitudes for many objects in terms of corresponding functions for the isolated objects. For arbitrary configurations and large spacings, the amplitudes were expanded as series of single scattered functions and their derivatives; "closed forms" involving differential operators were derived for two objects. For arbitrary spacings, the amplitudes were expanded as series of spherical harmonics to obtain algebraic sets of equations relating the multiple and single scattering coefficients. Series expansions were available for arbitrary configurations, and closed forms are given for two small objects.

6062 Engineering Report EDL-E66, "On Scattering and Reflection by Elliptically Striated Surfaces," J. E. Burke and V. Twersky, DA 36-039 SC-87499, 22 Oct 62, (82:8), Unclassified, AD 421 464.

SYLVANIA ELECTRIC PRODUCTS, INC., ELECTRONIC DEFENSE LABORATORIES (CONT.)

6062 (Cont.)

Previous work (Abstracts 7428J and 7829J and J. Acoust. Soc. Amer. 29 210, (1957)) showed that the specular reflection coefficients, and differential scattering cross-sections per unit area, of rough surfaces comprising random distributions of relatively arbitrary protuberances on a ground plane, may be approximated by simple closed forms involving the scattering amplitudes of the isolated protuberances. In this report, those general results are specialized to treat the case of rough surfaces made up of semi-elliptic cylinders. Closed forms for the power reflection coefficient, for the phase of the coherently reflected wave, and for the differential scattering cross-section are obtained by substituting appropriate approximations for the scattering amplitude of an isolated perfectly conducting semi-elliptic protuberance.

At high frequencies, the approximation used for the isolated scattering amplitude included the geometrically reflected term and the "shadow-forming" diffracted term; the fields for the distribution showed both multiple geometrical-reflection effects and "multiple-shadowing" effects. Illustrative numerical examples are given for semi-ellipses ranging from perpendicular strips through semi-circles to the limiting case of flat strips. Both horizontal and vertical polarizations at all angles of incidence are considered.

6063 Engineering Report EDL-E72, "Signals, Scatterers, and Statistics," V. Twersky, DA 36-039 SC-87499, 29 Jun 62, (18:8), Unclassified, AD 285 675.

Relations are sought among various "average" functions defined for a complex number ensemble. This includes the average total; coherent and incoherent absolute squared functions of the ensemble or "intensities;" coherent, average, and average square phases; variance of real and imaginary ensemble components; and covariance with reference to phase quadrature measurements of the instantaneous field. A formalism is outlined for developing scattering-function representations for the intensities and coherent phase. The development is illustrated by explicit results for "gas-like" random distributions of large tenuous scatterers. Direct relations are established between the statistical functions and the fundamental scattering parameters. Results facilitate inverting measured data to obtain the values of the fundamental parameters.

6064 Engineering Report EDL-E74, "Experiment and Theory for Scattering by Random Distributions of Spheres Versus Fractional Volume," C. I. Beard, T. H. Kays, and V. Twersky, DA 36-039 SC-87499 and DA 36-039 AMC-00088(E), 8 Oct 62, (115:14), Unclassified, AD 426 297.

Previous work on scattering from a random array is continued and summarized (see Abstracts 6054 and 6055). Included are results of two systematic programs of measurements and computations of: forward-scattered coherent phase; coherent, incoherent, and total intensities; and variances and covariance of phase-quadrature components of the instantaneous field. Separate, simultaneous measurements were made of all these functions versus the number N of spheres in the previously described container (or, after reduction, of the fractional volume) from essentially the "rare gas" limit (N = 25) to the other limiting case of an "amorphous solid" (N = 2150), Two relatively distinct "compression processes" for proceeding from one limit to the other with increasing N are compared with theory. For both processes the air flow moving the spheres was adjusted so that the measured coherent phase increased linearly with N; finer

SYLVANIA ELECTRIC PRODUCTS, INC., ELECTRONIC DEFENSE LABORATORIES (CONT.)

6064 (Cont.)

adjustments were made so that the amplitude of covariance was either (1) a minimum or (2) a maximum. For process (1), a two-phase "gas-crystal" scattering model, in which the ratio of crystal-type scatterers to total scatterers increases linearly with N, is adequate to account for the primary features of the experimental data. For process (2), qualitative accord is obtained by including some of the effects of scattering by "clumps" of spheres.

6065 Technical Memorandum EDL-M105, "Notes of Scattering by Gratings," V. Twersky, DA 36-039 SC-71053, 14 May 57, (35:18), Unclassified, AD 138 922.

A previous paper by the author ("On the Scattering of Waves by an Infinite Grating," IRE Trans on Ant. and Prop. AP-4, 330-45 (1956)), examined plane-wave excitation of an infinite grating of elements having an arbitrary cross-sectional form except for possessing symmetry with respect to the grating plane. A Green's function formulation was used and a functional equation was obtained which specified the response of the grating in terms of the scattering amplitude of a single, isolated element. In this report, the physics of the new mathematical model is considered further, and several applications are made. Also discussed is the relation of this treatment to several other models. Discussion here is limited to the reflection grating (protuberances on a ground plane) or, equivalently, to the symmetrical or anti-symmetrical components of the transmission gratings.

6066 Technical Memorandum Report EDL-M120, "A Method of Measuring Dielectric Properties of Ferroceramics at Microwave Frequencies," A. F. Wickersham, Jr., and N. J. Gamara, DA 36-039 SC-73170, 9 Oct 57, (10:4), Unclassified, AD 148 176.

Electromagnetic energy reflected from a ferroceramic surface suffers a phase change which is a function of a biasing potential across the surface. Preliminary experiments showed phase changes of about 1.4° to 12.4° in free space with X-band energy (8.5-12.4 Gc) at oblique incidence. A technique is suggested for measuring the phase shift by incorporating slabs of material as the side walls of a waveguide.

6067 Technical Memorandum EDL-M156, "Propagation through Random Distributions of Spheres," C. I. Beard and V. Twersky, DA 36-039 SC-75012, 24 Sep 58, (14:10), Unclassified, AD 206 263.

Previous theoretical results from Report EDL-E26 (Abstract 6048) are applied with modification to the problem of a plane wave scattering from and propagating through a slab-shaped region comprising a random array of spherical scatterers that are large compared to wavelength. An experimental check was performed withthe aid of a 5-mm range, using as a target an array of styrofoam spheres. A turbulent air stream kept the spheres in motion to provide a dynamic random array, and motion pictures of the array gave a record of its actual form from moment to moment. It was found that the time-average energy loss and the time-average phase shift of the coherent wave transmitted through the distribution are initially linearly proportional to the number of scatterers. However, with increasing concentration of scatterers, the slopes of the attenuation and phase curves decrease, due to packing effects. The magnitude of the incoherent transmitted wave is also given.

Note: Handwritten equations were quite difficult to read in the DDC copy.

SYLVANIA ELECTRIC PRODUCTS, INC., ELECTRONIC DEFENSE LABORATORIES (CONT.)

6068 Technical Memorandum EDL-M186, "Bibliography on Electromagnetic Wave Propagation," A. Matschke, DA 36-039 SC-78281, 1 Apr 59, (77:≈800), Unclassified, AD 216 404.

This bibliography covers over 800 references on the following topics: general properties of the ionosphere; electromagnetic-wave propagation in the ionosphere; meteor-burst propagation; electromagnetic-wave propagation in the troposphere; and radio astronomy. It includes only publications from five leading laboratories in these fields, and covers the time period 1947-1958.

6069 Technical Memorandum EDL-M260, "Scattering by Ellipsoids," J. E. Burke and V. Twersky, DA 36-039 SC-78281, 1 Mar 60, (49:9), Unclassified, AD 239 719.

Using elementary methods, high-frequency approximations are obtained for the fields scattered by an arbitrary body in three dimensions. These general results are then specialized to ellipsoids, and the far-field scattering characteristics of certain families of such surfaces are considered in detail. It is shown that there exists a universal intensity curve for the reflected field when the directions of incidence and observation are restricted to a fixed plane containing the center of the ellipsoid. In particular, in any plane containing the direction of incidence and the major axis of the ellipsoid, independently of the angle of incidence, there is a unique curve of intensity vs. angle with respect to the ray specularly reflected from the axis of the ellipsoid. The special case of the spheroid is also examined, and it is shown that for observation out of the plane containing the direction of incidence and major axis, if slowly varying angular effects are neglected and the shadow region discounted, the field scattered by a given spheroid is essentially a thick conical lobe of revolution whose maximum is the axially-specular cone. A family of spheroids is assumed to be illuminated by a ground based transmitter and, for each of the family, contours of constant intensity (on the ground) are calculated as a function of spheroid altitude.

6070 Technical Memorandum EDL-M286, "A Calculation of the Inverse Fourier Transform for a Complex Gamma Function Quotient," A. M. Matschke, DA 36-039 SC-85402, 11 Aug 60, (13:4), Unclassified, AD 242 554.

Presentation of detailed calculations for determining the inverse Fourier transform of a quotient of complex gamma functions, as well as the product of that quotient with the fractional argument of the gamma functions. The inverse transform of a relatively simple function (auxiliary transform) is calculated first. Then the inverse transform solution for the more complicated quotient of the gamma functions is built up by independently changing arguments of the auxiliary transform and its inverse while keeping the Fourier transform relations intact. The particular gamma function quotient has been factored from a dipole distribution function. The problem arises in the design of a quarter-wave artificial-dielectric polarizer.

6071 Technical Memorandum EDL-M455, "Numerical Results for Low Frequency Scattering by Elliptic Cylinders and by Isolated Semi-Elliptic Protuberances," J. E. Burke, E. J. Christensen, and S. B. Lyttle, DA 36-039 SC-87499, 1 Aug 62, (120:18), Unclassified, AD 410 333.

SYLVANIA ELECTRIC PRODUCTS, INC., ELECTRONIC DEFENSE LABORATORIES (CONT.)

6071 (Cont.)

Low-frequency approximations (closed-form and series) derived elsewhere (see Abstract 6052) for the fields scattered by elliptic cylinders and by semi-elliptic protuberances are applied numerically. The exact series are used to obtain numerical values for scattering amplitudes for a family of elliptic cylinders ranging from strips to circles, and for the corresponding semi-elliptic protuberances on ground planes. Numerical results are included for total scattering cross-section, forward- and backscattered intensity and phase curves, and far-field scattering patterns. These are presented for the two cases that the electric vector is parallel and perpendicular to the cylindrical axis for various incidence angles and eccentricities, and for values of $ka \leq 1.1$, where k is the wave number and 2a is the major axis length of the scatterers. Attention is restricted to the low-frequency range not covered by published tables of Mathieu functions.

6072 Technical Memorandum EDL-M725, "Low-Frequency Approximations for Scattering by Dielectric Elliptic Cylinders," J. E. Burke, DA 36-039 AMC-03404(E), 2 Jul 64, (21:13), Unclassified, AD 448 713.

Explicit low-frequency approximations were derived previously for scattering of a plane wave by a perfectly conducting elliptic cylinder (Abstract 7842J); in this report, analogous results are obtained for dielectric cylinders. The Mathieu function series solution is used to obtain low-frequency approximations in powers of the frequency. The far-field scattering amplitude is given to the sixth power of the frequency, and the external and internal fields are given to the third power. Arbitrary angles of incidence and observation, and arbitrary eccentricity are allowed.

SYLVANIA ELECTRIC PRODUCTS , INC., SYLVANIA ELECTRONIC SYSTEMS--EAST

6073 Interim Report (ESD-TDR-63-221), "Radar Interference Study," W. B. Mills, AF 19(604)-8484, Jan 63, (41:24), Unclassified, AD 403 538.

Angel returns were investigated over a period of 19 months, using an L-band FPS-8 radar located at Fort Dawes, Deer Island. Observed angels were classed into "single" and "group" types. Single types always occurred in a 100° azimuth sector over water at ranges of 5 to 20 nmi, were most common during summer, lasted from 15 seconds to 15 minutes, and generally appeared at midmorning. They never showed any motion and would sometimes fade for a time, only to reappear in the same spot. They normally displayed apparent Doppler modulation spectra peaked near 100 cps.

The less common group angels appeared in a line over water at ranges from 7 to 50 nmi, so closely spaced as to appear as a continuous line on the PPI. Film analysis showed them as a closely grouped array of targets, coherent to one another but containing random Doppler modulation with a bandwidth of 40 to 400 cps. The possible origin of the angels described is not discussed. (See next abstract).

6074 Final Report (ESD-TDR-64-252), "Radar Interference Study," W. B. Mills and J. F. Clark, AF 19(604)-8484, May 64, (104:3), Unclassified, AD 602 709.

SYLVANIA ELECTRIC PRODUCTS, INC., SYLVANIA ELECTRONIC SYSTEMS--EAST (CONT.)

6074 (Cont.)

Final report on a 2-1/2 year effort to establish the radar signatures of such interfering targets as weather, angels, and other unknowns which hamper the effectiveness of air traffic control radars. It includes 76 pages of graphical and tabular weather data and radarscope and equipment photographs. The single and group echoes described in the preceding abstract predominated, but also described are miscellaneous types including the patch echo, thin-line echo, striated ring echo, and the thermal-column echo, none of which was examined in any great detail. All of these echoes were felt to be directly connected with meteorological phenomena, except the patch echoes which were always confined to the same general area. Various types of weather patterns and their Doppler signatures are also discussed briefly.

SYRACUSE UNIVERSITY RESEARCH CORPORATION

6075 DSL Report R-94 (Special Engineering Report), "Significance of Target Characteristics upon Precision of Monopulse Radar," J. M. Caster and A. A. Walier, Jr., DA 36-039 AMC-00033(E), Jun 64, (61:9), Unclassified, AD 451 663.

Experimental and theoretical study concerned solely with application of of the monopulse technique. Its performance is compared with that of ordinary radar technique. The points of comparison are ability to resolve two simple targets, and ability to define the extent of a compound target. That a monopulse system indicates the direction of travel of a wave front is shown to be exactly true only in the case of a simple target, approximately true for a complex target, but not generally true for a compound target.

SYRACUSE UNIVERSITY RESEARCH INSTITUTE, ELECTRICAL ENGINEERING DEPARTMENT

6076 Report EE333-5610F3 (Final; RADC-TR-57-78C), "Back-Scattering Cross Section of an Antenna. Part 3: A Variational Solution for the Input Impedance of a Yagi Antenna," H. J. Juda and Y.-Y. Hu, AF 30(635)-2808, Oct 56, (26:16), Unclassified, AD 131 116.

Description of an analytical method for determining the input impedance of a two-element Yagi antenna, using the variational principle. Current trial functions were chosen and a resulting stationary expression for input impedance obtained. The solution is applicable for any choice of lengths, numbers, and separations of elements. Some numerical results for a two-element case are included. A similar presentation of a variational solution for the input impedance of a folded dipole was presented as Part 2 of the final report of this same study (see Abstract 2631). Part 1 was devoted to determining an analytical expression for the backscatter cross-section of a center-loaded cylindrical antenna (see Abstract 2630).

6077 Report EE492-5712T3 (Task Report 3; RADC-TN-58-79), "Study on the Scattering of Electromagnetic Waves by a Paraboloid of Revolution," A. T. Villeneuve, AF 30(602)-1640, 20 Dec 57, (38:8), Unclassified, AD 148 642.

The problem of scattering by a finite paraboloid of revolution is examined without reaching definite conclusions. Since the conducting surface is not a complete mathematical surface, no orthogonality properties are available for the

6077 (Cont.)

functions which describe the fields in the coordinate system employed, and an exact solution is not readily obtainable. Geometrical optics is used to solve the scattering of scalar spherical and plane waves, and also to obtain agreement of results in the case of a point source placed at the focus of the paraboloid. Approximation methods are used to obtain the scattering of a plane electromagnetic wave by a circular conducting disk.

6078 Report EE492-6005T9 (Task Report 9; RADC-TN-60-115), "Microwave Diffraction Field Measurements by a Modulated Scattering Technique," B. J. Strait, AF 30(602)-1640, 1 May 60, (60:22), Unclassified, AD 239 178.

The modulated scattering technique was investigated at X-band as a means of determining both electric- and magnetic-field distributions. Although the technique was not used for RCS measurement, it could be applied to the location of flare spots of complex radar targets. Basically, this method of measuring electric-field distributions employs a subminiature diode dipole scatterer to which audio-frequency modulation is applied. The scattered field is modulated by the changing impedance of the dipole and hence can be separated from the unmodulated microwave signals in the receiving system. Approximate theoretical analysis and some experimental results agree closely with experimental data on the diffraction field in and around a circular aperture. A distinct advantage of the technique is that fields are not disturbed by supporting devices or electrical apparatus.

6079 Report EE492-6201T13 (Task Report 13; RADC-TDR-62-46), "Small Resonant Scatterers and Their Use for Field Measurements," R. F. Harrington, AF 30(602)-1640, 31 Jan 62, (45:10), Unclassified, AD 273 847.

An analysis of small tuned scatterers and a proposal for their use in measuring electric and magnetic fields. The backscattered field from loaded objects is formulated, and it is shown that small resonant objects can produce a much greater backscattered field (on the order of 30 dB) than do small non-resonant ones. The theory is applied to short dipoles and small loops. Some advantages of resonant over non-resonant scatterers when used for field measurements are: the much larger scattered field that is obtained; enhancement of the magnetic moment of a loop scatterer without material change in its electric moment; and elimination of the requirement for a complicated modulation scheme. Moreover, modulation, if desired, can be accomplished in several ways not available with non-resonant scatterers, including modulation of the tuning reactance and of the frequency. Appendices give a formulation of the general two-port problem and tables of impedance parameters for the loaded dipole.

6080 Report EE492-6202F (Final Technical Report; RADC-TDR-62-133), "Investigation of Ground Antenna Characteristics," D. K. Cheng, AF 30(602)-1640, Feb 62, (72:-), Unclassified, AD 277 581.

(BD-3964) This final report summarizes engineering accomplishments from 25 Apr 57 to 31 Jan 62. Topics include effect of surface reflections on rain cancellation of circularly-polarized radars; study of the scattering of electromagnetic waves by a paraboloid of revolution; a new class of artificial dielectrics; measurements by modulated scattering methods; optimum progressive phase shifts for discrete endfire arrays; determination of phase-center location by amplitude measurements; and small resonant scatterers and their use for field measurements.

SYRACUSE UNIVERSITY RESEARCH INSTITUTE, ELECTRICAL ENGINEERING DEPARTMENT (CONT.)

6081 Report EE957-6301T3 (Task Report 3; RADC-TDR-63-15), "Measurement of Diffraction Fields of Finite Cones by a Scattering Technique Using Light Modulation," A. Vural, AF 30(602)-2646, 2 Jan 63, (94:23), Unclassified, AD 400 629.

Description of a new method for measuring microwave diffraction fields which employs a small photoconductive scatterer in a light-modulated scattering technique. This technique does not require external connections to the modulating element. A small dipole is centrally loaded by an element of photoconductive material. When the dipole is illuminated by a fluctuating light source, the resistance of the material follows this variation; if certain requirements are satisfied, the current distribution produced on the dipole by the diffracted field will be varied periodically. In turn, the scattered field set up by the current distribution is modulated at the frequency of the light pulses. X-band measurements for a circular aperture and a circular disk checked very well with previously published data. The technique was adapted for measuring the diffracted fields of finite conducting cones. Near-zone electric-field distributions for three cones (half-apex angles of 20°, 45°, and 67°) and a circular disk of the same diameter were mapped in detail; these are plotted in both two and three dimensions.

6082 RADC-TDR-63-543, "Scattering of Electromagnetic Waves by an Anisotropic Plasma-Coated Conducting Cylinder," H. H. C. Chen and D. K. Cheng, AF 30(602)-2646, Feb 64, (15:11), Unclassified, AD 433 108.

This report presents an analytical solution to the problem of scattering from an infinitely long circular conducting cylinder coated with a layer of anisotropic plasma (with a constant magnetic field in the axial direction) and situated in the field of a magnetic line source parallel to the cylinder axis. Complete expressions are obtained for the scattered electric and magnetic fields. Scattering by an anisotropic plasma column and that by an isotropic plasma-coated conducting cylinder are special cases of this problem.

6083 RADC-TDR-64-215, "Theory of Loaded Scattering," R. F. Harrington, AF 30(602)-2900, Jun 64, (26:15), Unclassified, AD 443 198.

A general formulation of the problem of electromagnetic scattering by an object having N terminal-pairs (ports) to which N loads or an N-port network is connected. The theory is applicable to backscattering and bistatic scattering, to reciprocal and non-reciprocal media, near-field and far-field scattering, and to passive and active loads. The representation is in terms of both open-circuit impedance parameters and short-circuit admittance parameters, and variational formulas are given for all parameters. The theory is specialized to the case of plane-wave scattering. Relationships between scattering parameters and commonly defined antenna parameters are given, and several applications of the theory are included.

SYSTEMS ENGINEERING GROUP, AIR FORCE SYSTEMS COMMAND

6084 WADC Technical Note 57-122, "Flight Investigation of an Airborne Radar Corner Reflector," H. S. George, Apr 57, (21:0), Unclassified, AD 118 176.

Experiments were performed to measure the extent to which a corner reflector would augment the cross-section of a jet aircraft, as seen by a Precision Approach Radar (AN/FPN-16). The improvement in cross-section was found to be somewhat less

SYSTEMS ENGINEERING GROUP, AIR FORCE SYSTEMS COMMAND (CONT.)

6084 (Cont.)

than the theoretically predicted value. The report contains plots of measured σ as a function of range for an F-86E bearing a square corner reflector 7.8 inches on a side.

6085 WADC Technical Note 57-223, "Flight Test Comparison of Three Precision Approach Radar Reinforcement Methods," H. S. George, Jun 57, (13:0), Unclassified, AD 130 766.

Discussion of experiments aimed at comparing three methods of reinforcing aircraft return for the Precision Approach Radar (PAR): cross-band beacon, X-band beacon, and an airborne corner reflector. The report contains negligible information on radar-reflection characteristics.

6086 WADC Technical Report 58-138, "Advanced Radar Simulator Techniques Using a Photo Map Storage," E. C. Hollinger, Apr 58, (39:4), Unclassified, AD 151 150.

A new radar-system trainer is needed to replace ultrasonic-tank systems, which become bulky for the large areas (750,000 square miles) required for some missions. Ultrasonic trainers also have several limitations, including resolution and both minimum and maximum ranges. The experimental demonstrator simulates ground return of an airborne radar by using a matched pair of photo-transparency maps containing terrain elevation and reflectivity data which are scanned synchronously by two optical systems. Block diagrams and descriptions of the equipment are given, but there were no specific studies of map preparation.

6087 WADC Technical Report 58-139, "A Light Reflective Method for Simulation of Airborne Radar," E. C. Hollinger, Apr 58, (7:0), Unclassified, AD 151 151.

A very brief description of an experimental optical radar map-simulator which was constructed and tested for the AN/APQ-T2. Limitations and advantages of the optical technique are mentioned.

6088 WADC Technical Report 58-140, "Study of Matched Photo Plate and Light Reflective Map Systems," E. C. Hollinger, May 58, (6:3), Unclassified, AD 151 147.

Two optical techniques of radar map simulation were compared with the aim of developing a better means for storing airborne radar information than current ultrasonic techniques. The first system involves storing data about terrain elevation and reflectivity on separate photo plates, then combining the stored information synchronously with a light-to-video transducer system to simulate the PPI display of an airborne radar (see also Abstract 6086). The second technique stores elevation and reflectivity data together on a relief map painted in a gray tone, from which a light scan and photoelectric transducer can generate a simulated video signal.

It was concluded that the first technique would be superior where compact and detailed storage of detailed information relating to large areas is needed. The second technique could more easily be brought to practical realization, would permit ready insertion or deletion of map intelligence (which the first would not), but would not be capable of providing as compact storage and ready assembly as the first.
Ed: This report is too brief and too poorly written to be of much value.

SYSTEMS ENGINEERING GROUP, AIR FORCE SYSTEMS COMMAND (CONT.)

6089 WADC Technical Note 59-6, "History of Chaff Development," G. W. Schivley, Jan 59, (8:0), Unclassified, AD 208 853.

A general history of the use, design, and development of chaff countermeasures from World War II to about 1957. Attention is focused on World War II chaff with emphasis on its use and effect on German air defense. The 1957 state-of-the-art is briefly described.

6090 ASD-TN-61-85, "Efficiency of Metal-Grid Spheres as Reflecting Bodies," Y. E. Stahler, Nov 61, (16:-), Unclassified, AD 269 233.

Plastic balloons covered by flat conductive grid and thin wire-mesh spheres were investigated as possible solutions to the unfavorable area-to-mass ratio of aluminized balloon satellites. The reflection efficiency of painted-grid and wire-grid spheres was determined for wavelengths ranging from 2 to 10 times the mesh dimensions. The grid-sphere's reflection characteristics were very good for incident wavelengths 8 to 10 times greater than the mesh dimensions. Spheres covered by a painted grid of adequate conductivity were found to reflect as efficiently as fully coated spheres. For optimum grid dimensions and wavelength, the energy reflected by the wire-grid sphere is 7 dB above that for a metalized sphere. Grid spheres, particularly wire-grid spheres, are found to be well suited for application as passive reflectors.

6091 ASD-TDR-62-439, "Applicability and Efficiency of Angle Return Arrays (Van Atta Arrays) in Passive Communication Satellites," Y. E. Stahler, Jun 62, (18:3), Unclassified, AD 284 396.

The use of Van Atta arrays in a passive satellite does not appear particularly profitable due to the lack of reasonable three-dimensional angle independence, of practical broad-frequency response, and polarization independence. Experimental and theoretical considerations indicate that overall reflection of a sphere of Van Atta arrays would be approximately 13 dB lower than the hypothetical maximum of 23 dB, relative to a plain sphere. Hence, the finite complex Van Atta array sphere will provide only about 10 dB gain over a plain sphere of similar size. Since a simply constructed wire-grid sphere can provide a gain of 7 dB, and needs to be only 1.4 times larger in diameter than a sphere of Van Atta arrays to achieve the same efficiency, it is concluded that the increased complexity of the Van Atta array is not worthwhile.

TACTICAL AIR COMMAND (LANGLEY AIR FORCE BASE)

6092 Report TAC-TR-64-34, "Operational Test and Evaluation. Visual and Electronics Aids for Identification of LZ's, DZ's, and EZ's," R. K. Ferris, R. Popejoy, and C. J. Corey, Oct 64, (40:0), Unclassified, AD 450 029.

LF, UHF, and X-band direction-finding equipment was evaluated to determine its ability to aid in directing aircrews to drop, landing, and extraction zones. The equipment included seven beacons, two corner reflectors, one flare, and two types of X-band chaff. A series of operational flight tests led to the conclusion that radar transponder beacons are the most valuable for these applications.

TECHNICAL INFORMATION AND LIBRARY SERVICES, MINISTRY OF AVIATION (GREAT BRITAIN)

6093 TIL/T.5376, "Measurement of the Doppler Frequency of a Single Radar Echo Pulse. Investigation of the Influence of Disturbances on the Measuring Accuracy," K. Besemer, W. Fogy, and C. Landgraf, Jun 63, (31:5), Unclassified, AD 418 618.

An MTI technique is analyzed which uses a frequency discriminator to measure Doppler frequency and can operate on a single radar echo pulse. Because the system does not depend on prf, the MTI disadvantage of blind velocities is eliminated in this method. Maximum permissible SNR's for different types of output are discussed. Experimental and theoretical results show good agreement.

Note: This is a translation of "Die Messung Der Dopplerfrequenz Eines Einzelnen Radarechoimpulses. Untersuchung Des Einflusses Von Stoerungen Auf Die Messgenauigkeit," (DVL Report 149, Feb 61, Germany).

6094 TIL/T.5381, "A Wide-Band Absorber for Electromagnetic Waves," J. Deutsch and P. Thust, Apr 64, (5:5), Unclassified, AD 438 475.

Description of a wideband absorber intended for use in anechoic chambers. A reflection factor of less than 10% is obtained over a relative band of 1:35, and over an angular range of 35°. The absorber is suitable for meter waves.

Note: This is a translation of a journal article (see Abstract 8400J).

TECHNICAL UNIVERSITY OF DENMARK

6095 Report S127-R39 (Scientific Report 1; AFCRL-65-162), "A Theoretical Investigation of Van Atta Arrays," T. Larsen, AF 61(052)-794, Nov 64, (36:25), Unclassified, AD 613 614.

A thorough analysis of the properties of a Van Atta reflector which takes into account mutual impedance and radiation from the elements. The Van Atta reflector consisting of dipole elements is first analyzed by calculating the open-circuit voltage induced at each element by an impinging plane wave. Next, a system of equations for calculating the currents in each antenna element is set up, which takes into account mutual impedances, characteristics of the transmission lines, and the induced voltage at the element itself and at its mate. After the currents are determined, the reradiated field is calculated from the theory of antenna arrays (only applicable for reflectors with all elements parallel); finally the properties of the reflector array are determined by calculating the differential scattering cross-section.

6096 Report S127-R40 (Scientific Report 2; AFRCRL-65-205), "Linear Van Atta Reflector Consisting of Four Half-Wave Dipoles," J. Appel-Hansen, AF 61(052)-794, Nov 64, (26:5), Unclassified, AD 613 607.

The reradiated field from a Van Atta reflector consisting of four parallel halfwave dipoles is calculated, using an analysis simplified somewhat from that used in Report 1 (previous abstract) by considering the transmission lines as phase shifters. The reflected field is found by superposition of three fields: (1) the field reflected due to the interconnection between antenna elements, (2) that due to the scattering effect of the elements, and (3) that due to the coupling between the antenna elements. Numerically obtained reradiation patterns, with mutual impedances both neglected and taken into account, are presented for dipole elements having lengths (in wavelengths) of 0.5, 1, 0.25, 0.75, 0.28, and 0.64.

TELECOMMUNICATIONS RESEARCH ESTABLISHMENT (GREAT BRITAIN)

6097 Technical Note 131, "Some Methods of Preventing the Reflection of Electromagnetic Waves at the Boundary between Two Dielectrics," R. H. Garnham, Aug 51, (41:6), Unclassified, AD 294 839.

Two methods of reducing the reflection of electromagnetic waves from the surface of a dielectric or boundary of two dielectrics are treated theoretically and experimentally. In the first, the surface is ruled with slots of rectangular cross-section having a depth of $\lambda/4$, analogous to the quarter-wave matching stub on transmission lines. With the second technique, wedge-shaped grooves of greater depth are used, analogous to a tapered matching section on a transmission line. Maxwell's equations are solved for each case and the nature of the evanescent surface waves is examined. Experimentally, the reflection coefficient of polystyrene was reduced from 0.225 for a plane surface to 0.006 for a surface matched with rectangular slots, and to 0.02 with wedge-shaped grooves.

TEXAS A & M UNIVERSITY, DEPARTMENT OF OCEANOGRAPHY AND METEOROLOGY

6098 [M.S.] Thesis, "Investigation of Tornado Models and Structure by Use of Radar," W. A. Finley, AF 19(604)-1564, May 57, (56:22), Unclassified, AD 201 374.

The duration, position, and configuration of the radar echoes produced by precipitation areas associated with isolated tornadoes were investigated by means of 10- and 23-cm radarscope photographs. A model of tornado structure is presented which is based on deductive reasoning from studies of radar echoes and previously conceived models. Radar-echo configurations characteristic of tornado-producing storms are explained with reference to several illustrative scope photographs. A technique is proposed whereby radar may be used as a tool for short-range tornado warning.

6099 Technical Note 4 on A & M Project 131, "An Investigation of the Atmospheric Physical Conditions Associated with Microwave Propagation," L. P. Riggs, AF 19(604)-1564, Mar 58, (65:20), Unclassified, AD 159 404.

Examines the interrelationship between observations made with 10- and 23-cm radars and those weather factors which might influence the "trapping" of radar energy in a thin tropospheric layer. The study was made in an attempt to evolve procedures whereby meteorologists can predict anomalous propagation of radar energy using ordinary weather observations. It appears that several factors contribute to the degree of refraction which causes trapping. The most sensitive parameter is reported to be the degree of stratification of layers from the surface to 5000 ft; when the height of the low-level moisture layer reaches this altitude, trapping is negligible. Procedures for preparing objective forecasts of anomalous propagation are given, along with numerous PPI photographs of anomalous-propagation echoes. Graphs of surface relative humidity, wind direction, and wind speed vs. time are compared with graphs of anomalous-propagation echo occurrences.

6100 M. S. Thesis, "Meteorological Significance of Frontal Thin-Line Angel Echoes Observed by CPS-9 Radar," D. B. Miller, Aug 59, (116:54), Unclassified, AD 221 168.

Angel returns from invisible or imperceptible sources were observed by a 3.2-cm radar at Texas A & M. Following a review of the recent literature concerning observations of various thin-line angels and the theories proposed to

6100 (Cont.)

explain them, eleven observations of angel echoes are presented and analyzed with the aid of numerous weather maps and PPI-scope photographs. Results show that the thin-line angel echoes coincide with the positions of macro-scale frontal systems. An hypothesis is presented to explain the appearance of certain angel-echo patterns observed in association with some of the thin-line echoes.

6101 Scientific Report 1 on A & M Project 179 (Reference 59-12T; AFCRC-TN-59-475), "Some Non-Precipitation Radar Echoes as Observed by CPS-9 Radar," S. G. Bigler, AF 19(604)-3864, Sep 59, (29:15), Unclassified, AD 225 977.

Observed on a 3.2-cm radar were angel echoes of the following types: (1) thin lines which are associated with dry-front wind shifts and which also precede squall lines and air-mass showers; (2) echoes arranged in layers aloft; (3) echoes which are uniform and diffuse; (4) fibrilliform echoes presumably resulting from thermals; and (5) mantle echoes which correspond to the outer boundaries of cumulus clouds. One or more of these echo types were photographed on 79% of the 37 radar operating days between 1 June and 23 July 1958. Meteorological conditions during the observations are described; first gust lines associated with scattered showers and thunderstorms are considered in some detail. Illustrations of the PPI and RHI presentations of these lines are included, as well as wind, pressure, and temperature records. It is concluded that these thin lines are the boundary of mesosystems and thus provide another method for study of mesosystem characteristics.

6102 M. S. Thesis, "A Study of Radar Reflectivities from Hurricane Debra, 24-25 July 1959," K. S. Durham, AF 19(604)-3864, Jan 60, (41:26), Unclassified, AD 232 691.

In this study of the metamorphosis of a hurricane, methods are outlined for calculating radar reflectivity, total attenuation, and rainfall rates; iso-echo contours are given for four fixed azimuths. Hurricane Debra was observed on 24-25 July 1959 by the 3.2-cm CPS-9 radar at Texas A & M. Several out of a series of more than 6000 PPI- and RHI-scope photographs of the storm are included; charts of calculated reflectivity are shown and compared with corresponding scope photographs. It is shown that weak evidence exists of a connection between radar reflectivity and both speed and direction of lateral oscillatory movement. A new calibration procedure is used for calculating precipitation rates and radar reflectivities.

Note: This material also appeared as part of a final project report (see Abstract 6105).

6103 M. S. Thesis, "An Investigation of Linear Predictability of the Duration of Air-Mass Showers," F. W. Crites, Jr., AF 19(604)-3864, Jan 61, (65:21), Unclassified, AD 249 242.

Meteorological data as well as observations by a 3.2-cm AN/CPS-9 radar were used to develop several regression formulas for the prediction of shower duration. A majority of the echoes had a duration of less than 30 minutes. A pronounced relationship is noted between echo duration and the change in echo dimensions during the first 15 minutes. A smaller, but still positive, correlation is indicated between echo duration and initial echo height.

Note: This material also appeared as part of a final project report (see Abstract 6105).

TEXAS A & M UNIVERSITY, DEPARTMENT OF OCEANOGRAPHY AND METEOROLOGY (CONT.)

6104 Scientific Report 3 on A & M Project 237 (Reference 60-24T; AFCRL-226), "Some Effects of Range upon AN/CPS-9 Radar Reflectivities in Thunderstorms," T. E. Sanford, AF 19(604)-6136, Jan 61, (42:20), Unclassified, AD 256 867.

This report mainly concerns an investigation of the combined effect of attenuation and filled portion of the radar beam on the calculation of radar-reflectivity factor Z. Storm and echo-top distributions, as well as Z itself, are presented graphically as functions of range. A 3.2-cm CPS-9 radar was used to measure echo height and radar reflectivity of central and southeast Texas thunderstorms. Median profiles of the reflectivities are constructed, and comparisons are made between reflectivities measured at various ranges. Regression curves are obtained which relate the product of the attenuation and beam-filling factors to the target distance from the radar. Results indicate that both attenuation of 3.2-cm radiation and beam filling are important factors in the radar equation and cannot be ignored even at close range when accurate measurements are required. The signal-depletion term appears more important than the beam-filling factor in power attenuation resulting from increased range.

Note: This material also appeared as part of a final project report (see Abstract 6105).

6105 Final Report on A & M Project 237 (Reference 60-24T; AFCRL-800), "Utilization of AN/CPS-9 Radar in Weather Analysis and Forecasting," T. E. Sanford, R. L. Inman, J. E. Arnold, et al., AF 19(604)-6136, Jun 61, (238:137), Unclassified, AD 263 541.

This report comprises several independent studies of different aspects of radar meteorology; of the material included, the following items concern radar reflectivity.

"Errors in Measurement of Radar Reflectivity Factor Z," R. L. Inman (7:1).

Brief discussion of factors which can introduce errors into measurement; for example, attenuation, range measurement, and the analyst himself. Two examples showing the computation of Z serve to illustrate the magnitudes of error encountered.

"Statistical Summaries of 1959 Texas Thunderstorms," R. L. Inman (19:11).

Computational procedures and profiles for Z are discussed, the profiles being presented graphically for Texas rain, hail, and tornado-producing thunderstorms.

"Summary of Texas Thunderstorm Observations for 1960," R. L. Inman (20:2).

The frequency of echo-top height, median radar-reflectivity factor Z, height of maximum reflectivity Z_{max}, and quartile profiles of radar reflectivity are discussed and are plotted vs. height for rain, hail of several size intervals, and damaging winds.

"Some Characteristics of Severe Texas Thunderstorms," J. E. Arnold (27:9).

Discussion of first echo and growth tops, storm-top activity prior to maximum height, tropopause penetration, storm-reflectivity profiles, and changes of the maximum-reflectivity height. Reflectivity profiles for storms before, during, and after hail fall are included, and the maximum height of reflectivity and Z fluctuation at 30,000 ft are plotted vs. time for storms producing hail and tornado

TEXAS A & M UNIVERSITY, DEPARTMENT OF OCEANOGRAPHY AND METEOROLOGY (CONT.)

6105 (Cont.)

"Some Non-Precipitation Radar Echoes as Observed by CPS-9 Radar," S. G. Bigler (13:10).

This material appeared as Scientific Report 1 (see Abstract 6101).

"A Study of Convective Precipitation as Revealed by Radar Observations, Texas 1958-59," R. A. Clark (22:14).

Convective echoes and their relation to the mechanisms of precipitation are analyzed from time-lapse PPI-scope photographs.

"A Study of Radar Reflectivities from Hurrican Debra, 24-25 July 1959," K. S. Durham (18:26).

This material also appeared as the author's thesis (see Abstract 6102).

"Some Effects of Range Upon AN/CPS-9 Radar Reflectivities in Thunderstorms," T. E. Sanford (14:20).

This appeared as Scientific Report 3 (see Abstract 6104).

"An Investigation of Linear Predictability of the Duration of Air-Mass Showers," F. W. Crites, Jr. (22:20).

This material appeared also as the author's thesis (see Abstract 6103).

"An Investigation of the Relation Between Sferics and Radar Parameters of Thunderstorms," H. H. McDaniel (25:16).

This material also appeared in another report (see Abstract 6106).

6106 Final Report on A & M Project 150 (Reference 62-11F; AFCRL-62-847), "Radar and Sferics Investigations of Texas Thunderstorms," G. L. Huebner, Jr., H. H. McDaniel, T. E. Sanford, and H. E. Sievers, AF 19(604)-2182, 30 May 62, (119:68), Unclassified, AD 287 919.

This report describes an investigation aimed at correlating the characteristics of rf noise due to sferics with meteorological variables so as to enable diagnosis and prediction of severe weather. Of four major sections of this report, two contain no radar information. The other sections primarily concern an investigation of six storms to determine whether changes in the spectral characteristics of sferics are correlated with changes in storm parameters, such as radar reflectivity, height and growth rate of echoes, and occurrence of hail or damaging winds. Data from a 3.2-cm CPS-9 radar are compared with data from specially-designed sferics equipment. Scope photographs of one storm are presented and values log Z are plotted on a height-ordinate and time-abscissa and analyzed for constant log Z. A frequency index, based on stroke rate and the amplitude mode of four of the frequencies investigated in this research (10, 50, 100, and 150 kc), showed reasonably good linear agreement with equivalent radar reflectivity. Moreover, despite the gross nature of the observational data, the results of this study by comparative radar and sferics observations suggest a correlation between the frequencies at the amplitude modes in sferics spectra and the updraft velocities in the storm-core vicinity.

TEXAS A & M UNIVERSITY, DEPARTMENT OF OCEANOGRAPHY AND METEOROLOGY (CONT.)

6107 M. S. Thesis, "Theoretical Investigation of the Applicability of a Dual-Frequency Radar System to the Study of Convective Liquid Precipitation," V. M. H. Von, NSF Grant G-13834, May 63, (87:37), Unclassified, AD 415 751.

Note: This thesis was later published as a scientific report (see Abstract 6108).

6108 Scientific Report on A & M Project 263 (Reference 63-22T), "Theoretical Investigation of the Applicability of a Dual-Frequency Radar System to the Study of Convective Liquid Precipitation," V. M. H. Von, R. A. Clark, J. J. Stephens, and V. E. Moyer, NSF Grant G-13834, 1 Sep 63, (87:37), Unclassified, AD 437 218.

Derivation of the radar equation with particular regard to precipitation and the incorporation of the rigorous Mie solution of the backscatter cross-section σ. For the 10.3-cm (WSR/TAM-1) and 3.2-cm (AN/CPS-9) dual-frequency radar system used, it is shown that at 3.2 cm the temperature dependence of σ is great and cannot be neglected, while at 10.3 cm this dependence is so slight that it can be ignored. A brief review of drop-size distributions is included; the Marshall and Palmer distribution ("The Distribution of Raindrops with Size," J. S. Marshall and W. McK. Palmer, J. Met. 5, 165-66 (1048)) is used to characterize the array of scatterers in precipitation volumes. This distribution is taken to be dependent on two parameters: the slope of the drop-size frequency distribution, and the size of the largest drop. Received power is determined for appropriate values of these parameters, and variations of frequency-distribution slope and received power with liquid-water content and rainfall rate are examined. Analysis reveals that the unattenuated power received by the CPS-9 is a linear function of the power received by the TAM-1. The advantage of the TAM-1, with its attenuation-free capabilities, over the CPS-9 suggests a suitable means for predicting unique values of the parametric variables; a method for determining these parameters is given.

Note: This report is a re-publication of the first author's thesis (see Abstract 6107).

6109 Scientific Report on A & M Project 263 (Reference 63-30T), "An Investigation of Precipitation Attenuation and Its Application in a Dual-Frequency Radar Morphology of Subtropical Precipitation," D. R. Greene, R. A. Clark, J. J. Stephens, and V. E. Moyer, NSF Grant G-13834, 15 Dec 63, (109:37), Unclassified, AD 437 215.

This investigation concerned precipitation attenuation and its application to the study of the physical process of convective rainfall. The effects of precipitation attenuation were observed with a dual-frequency radar system operating at 3.2 and 10.3 cm. Included are rigorous mathematical developments of the theoretical and analytical aspects of attenuation, with numerous graphs including attenuation cross-sections using Mie, Penndorf, and Rayleigh solutions. The attenuation factor k is calculated using the rigorous Mie solution for the total attenuation cross-section and the Marshall-Palmer drop-size distribution (see reference in Abstract 6108). The attenuation factor is related to rainfall rate R and liquid-water content M to obtain k-R and k-M relationships. Analysis reveals that the vertical velocity field in the cloud must be known in order to relate attenuation factor to rainfall rate. The problem of forward scattering by both solid and liquid precipitation is examined. It is shown that for small liquid-water drops, the amount of forward-scattered energy is insignificant; however, for large ice particles, forward scattering becomes important.

TEXAS A & M UNIVERSITY, DEPARTMENT OF OCEANOGRAPHY AND METEOROLOGY (CONT.)

6110 Scientific Report on A & M Project 263 (Reference 63-29T), "The Feasibility of a Dual-Frequency Radar System in Studying the Morphology of Subtropical Precipitation," R. A. Clark and V. E. Moyer, NSF Grant G-13834, 31 Dec 63, (120:62), Unclassified, AD 437 219.

Precipitation morphology was studied with the same two radars used previously (see Abstract 6108). Various techniques for determining the liquid-water content in clouds are examined, and fields of vertical motion are computed by the use of a continuity equation for liquid-water concentration. Attenuation coefficients for 3.2-cm radiation are determined from the dual-frequency system data and employed to estimate drop-size distribution. Also presented are empirical relationships between radar reflectivity and liquid-water content which utilize data from a single radar. Problems related to the estimation of precipitation intensity by radar are examined; variations are derived for the equations relating radar reflectivity and precipitation intensity to various parameters of drop-size distribution. Normalized backscatter cross-sections for Mie and Rayleigh scattering, along with attenuation cross-sections computed from the Mie, Rayleigh, and Penndorf equations, are presented graphically as functions of water- and ice-drop diameter. The rigorous Mie solution appears in an appendix.

Note: This report also appeared as the first author's thesis.

6111 Scientific Report on A & M Project 263 (Reference 63-31T), "Kinematical Relations among Radar-Observed Water Concentrations, Vertical Motions, and Liquid-Water Drop-Size Spectra in Convective Clouds," R. C. Runnels, R. A. Clark, and V. E. Moyer, NSF Grant G-13834, 31 Dec 63, (68:28), Unclassified, AD 437 216.

Following a brief discussion of cloud motions and a review of various convective-cloud models, a one-dimensional kinematical equation for vertical cloud motions is developed. This equation is based on the continuity of water substance and has parameters determined from radar-reflectivity measurements. The term in the continuity equation which accounts for the change of phase of water is found to be significant in consideration of the center of a convective cloud. Liquid-water concentrations determined from reflectivity data obtained with a 3.2-cm CPS-9 radar were found to be less than those inferred from median-volume diameters. The results of this investigation indicate that the mean vertical speeds of convective clouds can be determined with some degree of confidence from cloud parameters measured by a weather radar.

6112 Scientific Report on A & M Project 263 (Reference 63-32T), "On the Effects of Atmospheric Refraction on Radar Ground Patterns," L. G. Cobb and V. E. Moyer, NSF Grant G-13834, 31 Dec 63, (52:21), Unclassified, AD 437 217.

Ground patterns are examined, using PPI-scope photographs obtained with a 3.2-cm AN/CPS-9 radar. A normal pattern is presented for comparison with non-normal patterns, which are divided into groups according to size and location of anomalous echoes. Correlations are made between the echo patterns, their re-fractivity profiles, and the terrain. Anomalous ground-return echoes are related directly to topography, except when caused by elevated refracting layers. The amount of excess echo is proportional to the degree of super-refraction of the radar ray, which in turn is dependent on the gradient in and the thickness of the refracting layer. Radial patterns of anomalous echoes occur when the elevation angle of the antenna is less than 2° and when there is an elevated refracting

TEXAS A & M UNIVERSITY, DEPARTMENT OF OCEANOGRAPHY AND METEOROLOGY (CONT.)

6112 (Cont.)

layer, between 1500 and 3000 ft above the radar, in which the gradient of refractivity is greater than 48N/1000 ft (N = refractivity). Numerous plots of refractivity vs. altitude are presented with corresponding PPI photographs.

6113 Final Report on A & M Project 263 (Reference 63-35F), "Radar Study of Subtropical Precipitation," V. E. Moyer, NSF Grant G-13834, 31 Dec 63, (3:0), Unclassified, AD 437 400.

This report presents a brief history of the development of the 3.2- and 10.3-cm dual-frequency radar system used in the observations reported in preceding abstracts. No pertinent radar-reflectivity information is given.

6114 M. S. Thesis (A & M Project 311), "Climatological Study of Radar Echo Pictures from Albrook Air Force Base, Panama," C. Bowen, May 64, (49:11), Unclassified, AD 438 951.

Analyses were made of radar data obtained in April and July 1961 and January 1962 with a 3.2-cm CPS-9 radar in the Canal Zone. Areas of potentially high and low rainfall were determined from the analysis of monthly radar echo-occurrence charts included in this report. Study of radar-echo occurrence and topography cross-sections for a circle of 75-mile radius, disclosed that no single meteorological process can explain the cloud formations in the Panama area.

TEXAS INSTRUMENTS, INC.

6115 Final Summary Report Phase II, "Waterways Experiment Station Terrain Analysis Radar (Project WESTAR). System Implementation," DA 22-079 ENG-295, Jan 63, (160:0), Unclassified, AD 465 402.

Detailed description of a radar intended for use in laboratory studies of terrain reflectivity. More than half the report comprises a handbook for repair and maintenance of the equipment. No reflectivity information at all is included.

Note: Final Summary Report Phase I, "System Analysis," was issued in 1962, but was not obtained. Phase III, "Analysis of Results," was issued in January 1965 and is available from DDC as AD 465 403.

6116 Final Report (AFCRL-64-74), "Radar Analysis of the Moon. Phase II: Surface Properties," J. D. Shaw and C. A. Barlow, Jr., AF 19(628)-2478, 16 Jan 64, (107:101), Unclassified, AD 432 403.

Both theoretical and experimental attacks were made on the question of what knowledge of the lunar surface can be gained by radar probing. Initial theoretical studies examined the validity of the Huygens-Kirchhoff approximation that is commonly used in analyzing reflection from the lunar surface. It is indicated that this approach does not apply when the reflecting surface roughness is the order of λ. An improved method is developed for calculating radar reflection from a surface of arbitrary roughness; this approach separates the contributions due to the geometry of the surface from its electromagnetic properties. Results indicate that single-frequency radar studies cannot give unambiguous answers concerning physical and electromagnetic properties of the moon. Previous experimental work on the electromagnetic properties of various geological materials at radar frequencies is surveyed in some detail. Additional experiments performed on this program are described; these involved studies on twelve representative igneous rocks. Results presented include petrographic and chemical analyses.

THOMAS (A. S.), INC.

6117 Final Report M62-4-FR, "The Effect of Dielectric Coating on the Radar Cross Section of Typical Re-Entry Vehicles," Subcontract from MIT/LL, May 63, (95:21), Unclassified, AD 415 801.

A general formulation for the scattering from N concentric homogeneous cylindrical layers at oblique incidence. The scattered field is computed in the plane of incidence, for both TE and TM incident fields, as a function of angle of incidence, radius, shell thickness, and dielectric constant for both solid dielectric and dielectric-clad infinite cylinders. Inferences are drawn from the computations about scattering from dielectric-clad cone-spheres. The major conclusion is that the cross-section of the dielectric-clad cone-sphere configuration at nose-on axial incidence is significantly greater than that of the perfectly conducting shape of the same geometry. About fifty pages of detailed graphs relate normalized σ to the ratio of cylinder radius to λ for various aspect angles, dielectric constants, and shell thicknesses.

THE TRAVELERS RESEARCH CENTER, INC.

6118 Technical Memorandum 11 (TRC-20), "A Plan for the Integration of Radar and Routine Data in the Objective Analysis of Cloud, Precipitation, and Convective Activity," R. J. Reed, FAA/BRD-363, Dec 61, (17:3), Unclassified, AD 416 306.

Detailed procedures are outlined for statistical analysis of thunderstorms and precipitation, using contingency tables prepared empirically from PPI- and RHI-scope records, CAPPI data (the CAPPI display gives the horizontal distribution at fixed elevation), routine radar-summary data, and surface-observation data. Thunderstorm analysis is based on consideration of maximum echo height and intensity, while precipitation analysis is based on occurrence or non-occurrence of echoes. A brief discussion of cloud analysis suggests that radar can indicate a certain area within which clouds are present at intermediate levels, but radar currently has little to offer to the analysis of low clouds.

6119 Technical Publication 14 (7083-25), "Use of Radar Summary Maps for Weather Analysis and Forecasting," J. W. Wilson and E. Kessler, III, FAA/BRD-363, Jun 62, (51:12), Unclassified, AD 414 230.

Operational applications of the present U. S. weather radar observing and reporting system are documented and suggestions for its improvement are made. A study of radar summary maps collected with 10- and 10.7-cm radars shows that the echo areas reported are very closely associated with precipitation, and that the reported echo intensities and heights of echo tops are valuable for assessing the occurrence of thunderstorms and other precipitation types. Also described is a method for obtaining a probability of future echo occurrence at any particular point. The relatively small probability (60% or less) that must usually be assigned to point precipitation is attributed to lack of precision in locating particular echoes. The study suggests that the present system of encoding and reporting of radar echoes be abandoned in favor of a digital code suited for both manual and computer programming. Details of suggested collecting, encoding, and reporting techniques and a discussion of the periodicity of radar echo-intensity changes are included in the appendices.

THE TRAVELERS RESEARCH CENTER, INC. (CONT.)

6120 Technical Publication 21 (7044-41), "A Program for the Assembly and Display of Radar-Echo Distributions," E. Kessler, III and J. A. Russo, Jr., FAA/BRD-363, Oct 62, (73:9), Unclassified, AD 298 710.

Written in FORTRAN for the IBM 7090 computer, this program uses processing combinations to portray the intensity, scale, and vertical development characteristics of radar echoes. The data it employs is that collected by azimuthal scanning of the radar antenna at steps of antenna elevation and system sensitivity.

6121 Final Report (7457-113), "Weather Radar Technique Development," J. W. Wilson and J. W. Cole, Cwb-10709, Feb 64, (54:14), Unclassified, AD 433 912.

This report comprises several independent papers on various weather-radar measurement and analysis techniques. Those papers which contain information on radar reflectivity are as follows.

"Evaluation of Precipitation Measurements with the WSR-57 Weather Radar," J. W. Wilson (26:11).

Quantitative data collected with a 10-cm WSR-57 radar during five rainstorms and two snowstorms at Atlantic City are compared with precipitation data from 60 recording raingauges within 100 miles of the radar. An analysis of errors made in transferring PPI photographs to digitized arrays and in quantizing echo intensity indicates that reducing these errors would not substantially improve the accuracy of the radar measurements. The relationship between radar-echo intensity and rainfall rate was found to vary from storm to storm. A chart, based on an average relationship developed in this study, is presented for converting echo intensities to rainfall intensities.

"Statistics Related to Shape and Scale of Pattern Elements," J. W. Cole (7:0).

It is shown that simple correlation procedures can be applied to provide objective measures of the average lengths of echo and echo-free areas in a radar pattern.

"Summary of Experience Associated with Manual Digitizing and Computer Processing of WSR-57 PPI Weather-Echo Patterns," J. W. Wilson (9:3).

Collecting, digitizing, and computer processing of radar data are reviewed, and the time required for each is specified. It is also shown how echoes due to anomalous propagation can seriously interfere with interpretation of weather from PPI photographs.

TRG, INCORPORATED

6122 Scientific Report 2 (TRG-121-SR-2; AFCRC-TN-60-575), "On the Green's Function for a Circular Cylinder," Stephen Barone, AF 19(604)-3476, 13 Jan 60, (81:12), Unclassified, AD 245 423.

An analysis shows how as the radius of a cylinder becomes large, the Green's function for the cylinder passes into the Green's function for a plane. No restrictions are placed on the boundary condition on the cylinder surface. The asymptotic evaluation of the Green's function is carried out for a cylinder which obeys an impedance boundary condition. Particular attention is given to the range of values of the complex impedance where surface-wave terms appear in the evaluation. A similar procedure is pursued for a plane which obeys an impedance boundary condition, and plane and cylinder results are compared. The attenuation coefficient is derived for a purely reactive cylinder and an example is given for a uniform, lossy dielectric cylinder.

TRG, INCORPORATED (CONT.)

6123 Final Report, "Scattering from Rotationally Symmetric Metallic Bodies," M. G. Andreasen, Subcontract from MIT/LL, Apr 64, (81:5), Unclassified, AD 610 607.

A theoretical evaluation of electromagnetic scattering from metallic bodies of revolution for an arbitrary longitudinal cross-section. The problem is solved by an exact integral equation method. The validity of the computer program developed has been verified by comparing the results for scattering by a sphere with exact analytical results which are available for this special case. Numerical results are presented for the current distribution induced on a number of test bodies such as a rod, a cone-sphere, and a disk.

TRW SPACE TECHNOLOGY LABORATORIES, INC.

6124 Report 6120-0040-RU-000 (BSD-TR-61-36), "On Radiation in a Randomly Inhomogeneous Medium," W. C. Meecham, AF 04(694)-1, Sep 61, (23:5), Unclassified, AD 266 184.

Scalar radiation from a point-source in a randomly inhomogeneous medium is considered. Both the average solution and the fluctuation about the average are determined for cases where fluctuations are small. It is found that energy is transferred from the average to the fluctuation field at a rate dependent upon the long-wavelength components of the random fluctuation in the medium; also, the phase velocity of the average solution is lowered. Both of these characteristics are dependent to lowest order upon second-order scattering processes; single scattering produces no average effect. The point-source solution is used to find the equation governing general average fields propagating in the medium. An example is given using a Gaussian correlation function for the medium fluctuation; both the change in phase velocity and the rate of energy loss from the average beam are found.

6125 Report TN-60-0000-09129, "The Radar Cross Section of an Artificial Flare," R. S. Margulies, Jul 60, (6:6), Unclassified, AD 453 574.

A method of calculating the radar cross-section of a flare is developed. The flare is assumed to act as a source of electrons which move radially outward from a center. The scalar wave equation is applied, and the method of spherical waves of quantum mechanics is then used to predict the cross-section. The vector character of the problem is ignored, although the author states that the effect is negligible. (See also Abstracts 6126 and 6127).

6126 Report 6110-7466-RU-001 (BSD-TDR-62-301, Part I), "Electromagnetic Scattering from a Spherical Nonuniform Medium. Part I: General Theory," D. Arnush, AF 04(694)-1, Oct 62, (20:6), Unclassified, AD 289 614.

Scattering of electromagnetic waves by a spherically symmetric continuous dielectric is examined. The dielectric constant is assumed to be an arbitrary function of radius. Two distinct methods for calculating the scattering amplitude are derived. It is shown that the scalar approximation is generally very poor. The radar cross-section is discussed in some detail.

6127 Report 6110-7466-RU-002 (BSD-TDR-62-301, Part II), "Electromagnetic Scattering from a Spherical Nonuniform Medium. Part II: The Radar Cross Section of a Flare," R. S. Margulies and F. L. Scarf, AF 04(694)-1, Oct 62, (19:9), Unclassified, AD 289 615.

TRW SPACE TECHNOLOGY LABORATORIES, INC. (CONT.)

6127 (Cont.)

The exact solution is calculated for the radar cross-section of a plasma having an electron concentration proportional to r^{-2} and compared with the scalar approximation. It is found that the exact solution can be orders of magnitude smaller than any of the usual approximations.

6128 Report 6110-7837-RU-000 (BSD-TDR-62-350), "Backscatter from Inhomogeneous Media," P. J. Lynch, AF 04(694)-1, Nov 62, (29:11), Unclassified, AD 295 625.

This mathematical treatise is concerned with the backscatter of scalar and vector waves from spherically symmetric repulsive potentials for which the index of refraction is a continuous function of $\vec{r}$ and has a unique zero for some $\vec{r}_o$. The WKB approximation is used. The scalar-wave problem is studied by investigating the equivalent problem of electron backscatter from repulsive potentials. The vector problem is studied as electromagnetic backscatter from an inhomogeneous dielectric; the result is three-quarters of the scalar approximation in the extreme geometrical-optics limit.

6129 Report 6110-7892-RU-000 (BSD-TDR-62-375), "A Theorem on Electromagnetic Backscatter," R. J. Wagner and P. J. Lynch, AF 04(694)-1, Dec 62, (9:6), Unclassified, AD 295 505.

A theorem is proved which gives sufficient conditions under which electromagnetic backscatter from an inhomogeneous object vanishes identically. The theorem is as follows: If a plane wave is incident along the axis of symmetry of an axially symmetric scatterer, and if the relative permittivity and permeability of the obstacle satisfy the relation $\epsilon(\vec{r}) = \mu(\vec{r})$, then the radar cross-section is identically zero for all frequencies.

6130 Report 6433-6005-RU-000 (BSD-TDR-64-85), "A Model for the Calculation of Radar Backscatter from Underdense Hypersonic Turbulent Wakes," W. H. Webb, AF 04(694)-440, 8 Jun 64, (16:13), Unclassified, AD 449 234.

(BD-7882) The consequences of assuming self-preservation for a hypersonic turbulent wake are examined. Estimates of turbulent fluctuations and scale lengths for slender and blunt bodies are given and a model suggested for calculating underdense radar backscatter.

6131 Final Report 8625-6006-RU-000 (DASA MIPE 544-61; AFCRL-62-753), "The Study of a Method to Reduce Electron Density in the Ionospheric D-Region by Means of High-Powered Ground-Based Transmitters," P. Molmud, S. Altshuler, and J. H. Gardner, AF 19(604)-8844, Sep 62, (206:63), Unclassified, AD 287 186.

A study was made of a method of decreasing the electron density in the D-region by heating the electrons with intense electromagnetic radiation. This increases the electron attachment rate and thereby decreases the electron density. Relevant D-layer rate processes are reviewed and incorporated into a detailed analysis of the influence of a perturbing electromagnetic pulse upon the variation of electron density. The theory of conductivity of weakly ionized gas is reviewed and augmented to include dependency on field strength. Equations describing the nonlinear radial propagation of a powerful wave in a weakly ionized inhomogeneous

TRW SPACE TECHNOLOGY LABORATORIES, INC. (CONT.)

6131 (Cont.)

medium are derived and numerical solutions obtained which describe the vertical propagation of waves through a heavily perturbed D-region. It is found that the powerful wave modifies the electron-density distribution. The combination of high frequency and optimum power level provides a channel of decreased electron density in the D-region through which a wanted wave may propagate with greatly reduced attenuation. Experiments for obtaining useful quantitative information about the D-region are discussed; it is suggested that a D-layer probe be constructed in the Arctic. A transmitter in the megawatt power range, antenna gain of 40 dB, and frequency of ≧ 100 Mc are required.

6132 Report 9990-6037-NU-000 (Translation Series No. 65), "Probable Dimensions of Roughness of Lunar Micro-Topography," N. N Sytinskaya, Mar 62, (7:8), Unclassified, AD 279 460.

It is suggested that knowledge of the fine-scale structure of the lunar surface can be obtained by comparing the characteristics of optical radiation reflected from the surface with those of specularly reflected decimeter radiation. Mean dimensions of roughness appear to be between 0.01 and 10.0 cm.

Note: Translation of Izyestiya Komissii Po Fizike Planet (Kharkov), No. 1, 81-84, (1959).

UNITED AIRCRAFT CORPORATE SYSTEMS CENTER

6133 Air Weather Service Technical Report 180, "Preliminary Operational Application Techniques for AN/TPQ-11," R. J. Boucher and R. A. Wexler, AF 19(628)-3357, Sep 64, (100:13), Unclassified, AD 609 305.

Presents a functional description and operating instructions for a modified prototype AN/TPQ-11 vertical-beam K_a-band radar, and discusses the application of this radar as a tool in local forecasting. Weather radars operating at S-, C-, X-, and K-bands are discussed briefly, with reference to factors determining the choice of a given band of operation. The characteristics and detectability of clouds and precipitation are examined, and the bright band is attributed to the change in dielectric constant of snowflakes as they melt in falling through the 0°C level. The reduced echo intensity below the bright band is attributed to the increase fall velocity the snowflakes attain upon melting. It is pointed out that the bright band may also be produced by ice particles suspended in showers or thunderstorms. THI (Time Height Indicator) radarscope photographs and discussions provide a good reference for the recognition and interpretation of most cloud types. Angel echoes are discussed briefly, and attributed to atmospheric discontinuities of moisture and temperature.

UNITED RESEARCH, INC.

6134 Final Report, "Turbulence Measurements at High Altitudes by Second-Difference Interferometry," D. W. Batteau, T. E. Beling, and R. H. Spencer, DA 36-039 SC-84963, 31 Oct 61, (60:3), Unclassified, AD 272 883.

A technique called "second difference interferometry" is advanced as a means of determining the spatial distribution and motion of a pair of radar reflective targets or of an aggregate of targets. The basis of the technique is that two or more radar-illuminated targets produce an interference pattern in

UNITED RESEARCH, INC. (CONT.)

6134 (Cont.)

space that is characteristic of the targets. Motion of the targets causes motion of the pattern, and hence knowledge of the motion can be obtained by examining the interference pattern with an array of fixed receiving stations. The theory of the system is expounded and experiments on two balloon-borne 6-inch spheres are described. Application to measurement of high-altitude turbulence is mentioned. (See also next abstract).

6135 Quarterly Progress Report 1, "Measurement of Turbulence at High Altitudes," R. H. Spencer, DA 36-039 SC-89087, 31 Aug 62, (40:9), Unclassified, AD 286 274.

Work was continued on the system described in the preceding abstract. This report includes a theoretical analysis of the technique when applied to a turbulent cloud of targets, such as a chaff cloud. It is here shown that simple cross-correlation processing of the data provides a measure of rms particle-pair spacing along two orthogonal axes through the chaff cloud. Brief comments are made on the dispersion of chaff by turbulence, and its clumping, radar cross-section, scintillation, and fall velocities. A proposed 10-cm system is discussed. An appendix treats the behavior of the second-difference interferometry signals developed from cloud expansion, translation, rotation, and shear.

UNIVERSITY OF ALASKA, GEOPHYSICAL INSTITUTE

6136 Scientific Report 1 (AFCRC-TN-59-400), "Experiment Luxembourg," G. C. Rumi and C. G. Little, AF 19(604)-3880, Dec 58, (51:29), Unclassified, AD 216 316.

This report discusses the theoretical aspects of a radio-wave interaction experiment designed to determine electron-collision frequency and density as a function of altitude in the arctic D-region. The outline of the proposed experiment is preceded by a brief history of the Luxembourg effect and discussion of the basic theory.

6137 Final Report, "Arctic Propagation Studies at Tropospheric and Ionospheric Modes of Propagation," L. Owren, H. F. Bates, R. D. Hunsucker, et al., AF 19(604)-1859, Oct 59, (101:31), Unclassified, AD 231 504.

Describes a program concerned with the measurement of backscattered energy from the E- and F-layers by using an oblique-incidence, sweep-frequency sounder operating at HF and located at College, Alaska. Attention is devoted to echoes from randomly distributed, field-aligned irregularities in the ionosphere, and from discrete patches of irregularities. Other areas briefly investigated were: (1) auroral echoes at radar frequencies of 41.15 and 196 Mc; (2) prediction of auroral and ionospheric storms; (3) whistlers and VLF propagation; (4) ionospheric absorption as a function of propagation frequency; and (5) long-distance propagation across the polar regions between Alaska and Scandinavia. Vertical incidence measurements are also discussed.

6138 Scientific Report 1 (AFCRL-194; UAG-R115), "An HF Sweep Frequency Study of the Arctic Ionosphere," H. F. Bates, AF 19(604)-1859 and AF 19(604)-5574, Apr 61, (76:45), Unclassified, AD 257 534.

UNIVERSITY OF ALASKA, GEOPHYSICAL INSTITUTE (CONT.)

6138 (Cont.)

Discussion of observations made during 1958 and 1959 using a sweep-frequency, HF, oblique sounder located at College, Alaska, including illustrations of selected echo groups. The majority of echoes when sounding toward geomagnetic north were direct F-region scatter of two main types, 1F and constant-range echoes; some E-region echoes were also observed. It is concluded that the echoes represent scattering from irregularities aligned along the geomagnetic field. Characteristics and possible causes and effects of the various echoes are discussed. An historical survey of mid-latitude scatter research is included, as well as an outline of the sweep-frequency program at the Geophysical Institute and typical records obtained during two years of observations. Also described are: (1) the theoretical aspects of scatter from electron density irregularities; (2) theoretical models to explain two of the more common echoes; and (3) applications of these echoes to ionospheric research.

6139 Final Report (RADC-TR-61-217), "Radio Properties of the Auroral Ionosphere -- Part I," L. Owren, AF 30(635)-2887, Mar 62, (88:34), Unclassified, AD 297 288.

This report comprises a collection of essentially self-contained papers dealing with refraction, absorption, and scintillation of radio waves propagated through the auroral ionosphere. It is divided into three separately bound parts, of which only Part I was obtained for abstracting.

Part I consists of a single paper entitled "Theory of Radio Wave Scattering in the Auroral Ionosphere," by Lief Owren. Although the program deals primarily with signals (e.g., radio star signals) transmitted through the ionosphere, rather than radar signals reflected from it, this paper is valuable as it reviews the basic theory of ionospheric scattering from a very general point of view.

Ed: The material of Parts II and III appears to be only marginally related to radar reflectivity, with the exception of part of the discussion in a paper in Part III entitled "Observations of High Latitude Radio Aurora," by Leif Owren.

6140 Final Report (UAG-R128; AFCRL-62-596), "Research Directed Toward Correlation of Visual Aurora with Auroral Radar Echoes," R. S. Leonard, AF 19(604)-7446, Aug 62, (5:1), Unclassified, AD 285 981.

Very briefly describes purpose and equipment for experiments performed to correlate visual aurora with VHF auroral radar echoes.

Note: Results are summarized in a paper published in J. Phys. Soc. of Japan 17, Supplement A-1 (1962).

6141 Final Report (UAG-R130), "Environmental Studies for Radar Operations in the Auroral Zone, Part I," W. L. Flock, AF 04(647)-179, Oct 62, (82:45), Unclassified, AD 290 270.

Possible correlation between VHF radio aurora and geomagnetic activity was investigated experimentally. VHF radio aurora were observed over Barrow, Alaska, by a 41-Mc radar at Lotzebue, Alaska, and telluric current activity was observed at Barrow. These two quantities show a high correlation, particularly for onsets of major activity. The correlation is clearly highest for overhead or nearly overhead aurora and drops off for separations of 300 km or more. The report also includes a background discussion of the auroral ionosphere, and description of recording facilities and equipment. Part II (not obtained for abstracting) is classified and includes data on UHF radio aurora.

UNIVERSITY OF ALASKA, GEOPHYSICAL INSTITUTE (CONT.)

6142 Final Report (UAG-R139; AFCRL-63-184), "Study of the Arctic Ionosphere by Means of Step-Frequency Backscatter Sounding," H. F. Bates, AF 19(628)-440, Jun 63, (14:2), Unclassified, AD 412 950.

Describes the installation and operation of a step-sounder at College, Alaska. Preliminary experimental data are shown which indicate that direct backscatter echoes from E- and F-regions predominate when sounding north. Briefly discussed is a southerly motion of radio auroral echoes as sunset approaches which is similar to optical observations.

UNIVERSITY OF ARIZONA, INSTITUTE OF ATMOSPHERIC PHYSICS

6143 Scientific Report 11, "Characteristics of Summer Radar Echoes in Arizona, 1956," B. Ackerman, AF 19(604)-1931, 8 Jul 59, (73:12), Unclassified, AD 226 196.

This report is mainly concerned with the statistics of meteorological radar echoes observed with a 3.3-cm TPS-10 RHI radar, and with the nature of their sources. The frequency of occurrence of echoes and their height of formation, the growth and duration of echo clouds, and the location of precipitation areas, as well as their movement and propagation with respect to areal and diurnal variations, are each discussed in detail. The prime sources of new echoes were found to be over land from 3000 to 5000 ft in elevation. First echoes were found at a large number of heights; the top heights of echoes were distributed in a Gaussian frequency curve having mean and modal values around 22,000 ft. The bases of first echoes occurred at heights ranging from 6000 to 26,000, with marked preference for levels around 10,000 ft. A difference in the speed of precipitation areas and component areas is attributed to the formation of new echoes up- or downstream from older ones. Frequency distributions are shown for the heights, thickness, temperature, growth, duration, and movement of echo tops and bases. Also presented are maps of echo movement, location, and time of first-echo formation and precipitation areas. Radar shadowing by mountains is discussed in an appendix.

6144 Scientific Report 12, "Calculations of Mie Back-Scattering of Microwaves from Ice Spheres," B. J. Herman and L. J. Battan, NSF Grant G-8216, 31 Dec 59, (11:10), Unclassified, AD 236 312.

Normalized backscattering cross-section σ_b of spherical ice particles were calculated from the complete Mie equations for small intervals of ka where a = particle radius, up to ka = 30. The results show that σ_b tends to increase with ka over this range, whereas previous results for ice spheres for ka < 6 and for water spheres had suggested a decline would be encountered. Over a large range of particle size, backscattering from large hailstones is seen to greatly exceed that from water spheres of equal size. These calculations may explain the extremely large radar reflectivities that have been observed for thunderstorms containing hail, and the experimental observations of Atlas et al. (Abstract 5415) who measured unexpectedly large backscatter cross-sections for large hailstones. Calculations for selected values of ka up to 500 show that σ_b reaches a peak for ka = 60, and declines for higher ka. It is suggested that the main factor causing the large cross-sections of ice spheres is the small absorption.

Note: This material also appeared as a journal article (see Abstract 8243J).

UNIVERSITY OF ARIZONA, INSTITUTE OF ATMOSPHERIC PHYSICS (CONT.)

6145 Scientific Report 15, "Calculations of Mie Back-Scattering from Melting Ice Spheres," B. M. Herman and L. J. Battan, 1 Sep 60, (28:5), Unclassified, AD 245 987.

Calculations of the normalized backscatter cross-section σ_b of ice spheres surrounded by shells of liquid water have been made, from an extension of the Mie theory to a two-layer model. Curves of σ_b as a function of the thickness of the liquid-water coating are presented for variously sized spheres and 3.21-, 4.67-, and 10.0-cm radiation. It is shown that, depending upon the size of the sphere and the wavelength of the incident radiation, the backscatter may either increase or decrease as the ice acquires a liquid-water shell. During the course of melting, certain-sized spheres display interference phenomena which in some instances may lower the value of σ_b by several orders of magnitude. Comparisons are made between theoretical results presented here and experimental measurements of σ_b for melting ice-spheres performed by Atlas et al. (see Abstract 5415).

6146 Scientific Report 16, "Back-Scattering of 3.21-cm Radiation by Water Bubbles," L. J. Battan and B. M. Herman, Nonr-2173(03) and NSF Grant G-8216, 15 Aug 60, (14:8), Unclassified, AD 252 268.

Calculations were made of the backscattering of 3.21-cm waves from water bubbles ranging in diameter from 0.2 to 5.0 cm. Film thicknesses between 2 and 1000 microns were considered. As diameter D increases, backscatter cross-section shows a gradual upward trend, but sharp minima occur at intervals of D which are integral multiples of $\lambda/2$. Backscatter cross-section increases monotomically with film thickness, the rate of increase being greatest at small thicknesses. Except at intervals of D close to $\lambda/2$, the backscatter cross-sections of bubbles are higher than those of water spheres having the same mass.

6147 M. S. Thesis, "A Study of Radar Angels," J. W. Inman, May 64, (59:31) Unclassified, AD 441 100.

The theory of clear-air radar echoes is combined with observations made with a 3.25-cm vertically-directed, pulsed Doppler radar. These angel echoes appear to fall into two categories: persistent, narrow horizontal layers and small, transient dot echoes. Radar theory demands very large gradients of refractive index to account for far-field observations, but the gradients required would be less if the scattering can be considered to occur in the near zone of the radar. Oscillations in the backscattered energy of a layer angel are shown to correspond to gravity-wave oscillations. It is suggested that a gravity wave might induce changes in temperature and water-vapor distribution, thereby modifying the refractive-index gradients. Furthermore, focusing and divergence effects could possibly be produced by fluctuations in the concavity of the reflecting layer. The dot angels are attributed to refractive-index gradients set up by thermal bubbles, or simply to turbulent eddies in or near large temperature gradients. Both frequency of occurrence and height of dot angels seem to increase with increasing surface temperature and in the vicinity of convective turbulence.

UNIVERSITY OF CALIFORNIA, DEPARTMENT OF MATHEMATICS

6148 Technical Report 2, "Reflection and Transmission of a Plane Wave by a Flat Cloud," E. Pinney, Nonr-222(04), Jun 61, (16:1), Unclassified, AD 260 346.

UNIVERSITY OF CALIFORNIA, DEPARTMENT OF MATHEMATICS (CONT.)

6148 (Cont.)

In this theoretical analysis a "cloud" is defined as an infinite slab bounded by two parallel planes and consisting of minute spheres with diameters small compared to λ and with volume much less than that of the cloud. The Rayleigh scattering law is used to resolve the impinging electromagnetic energy into transmitted, reflected, and dissipative components just as in a lossy dielectric. The incident wave is resolved into TM and TE waves with respect to the face of the cloud. A polarization effect is shown to exist near incidence angles of 45°. The reflection coefficient for a conducting sphere is treated along with the lossy dielectric case above.

UNIVERSITY OF CALIFORNIA, ELECTRONICS RESEARCH LABORATORY

6149 Report 70 (Series 60, Issue 191), "Back-Scatter from a Right-Circular Cone," A. Shostak and D. J. Angelakos, N7onr-29529, 26 Jul 57, (11:2), Unclassified, AD 148 295.

Backscatter characteristics were experimentally determined at 9.3 Gc for three right-circular metallic cones having base diameters of 2λ, λ, and $\lambda/2$; all had 15° apex angles. For later, more accurate measurements, see Abstract 6155.

6150 Series 60, Progress Report 21 (Quarterly Progress Report), N7onr-29529, 15 Jul 58, (16:3), Unclassified, AD 202 218.

Short progress statements are given for each of several projects, of which two are pertinent: "Diffraction of Plane Waves by a Circular Aperture in a Thin Infinite Plane Conductor," and "Backscattering Cross-Section of Oblate Spheroids."

6151 Series 60, Issue 232 (Report 84), "Scattering of Microwaves by Figures of Revolution," J. S. Honda, S. Silver, and F. D. Clapp, N7onr-29529, 16 Mar 59, (36:11), Unclassified, AD 216 595.

Analysis and implementation of the image-phase technique for measuring backscatter cross-section are discussed, including mechanical and electrical details and limitations imposed on the actual setup. Calibration was to a copper reference sphere 6 inches in diameter. Experimental observations for spheres, cones, and prolate spheroids are compared with theoretical calculations; conjectures are made to explain a large discrepancy for the prolate spheroid. Graphs show the scattered field as a function of aspect angle.

6152 Series 60, Issue 237 (Report 88), "Reciprocity Theorems for Electromagnetic Fields Whose Time Dependence Is Arbitrary," W. J. Welch, N7onr-29529, 11 Jun 59, (13:4), Unclassified, AD 227 407.

The advanced- and retarded-potential solutions to Maxwell's equations are used to derive two reciprocity theorems. The first involves electromagnetic potential while the second involves the electric and magnetic fields directly. Conditions for the first theorem are that the sources be in free space and that their Fourier transforms exist. In the second, conductivity of the space is taken to be zero, and the permittivity and permeability are assumed to be simple scalar functions of position. The second theorem is used to derive a variational expression for scattering of electromagnetic waves from a perfect conductor.

UNIVERSITY OF CALIFORNIA, ELECTRONICS RESEARCH LABORATORY (CONT.)

6153 Series 60, Issue 243 (Report 90), "New Results in Back Scattering from Cones and Spheroids," A. Olte and S. Silver, N7onr-29529, 15 Jul 59, (24:13), Unclassified, AD 225 150.

Experimental results are given for backscatter cross-sections of cones, prolate spheroids, and oblate spheroids, after a brief résumé of the image-plane measurement technique used. Calibration data show that attainable accuracy is better than 0.5 dB for cross-sections on the order of those of spheres 3 inches in diameter. Cross-section data for various target aspects are compared with geometrical-optics cross-sections and those obtained by various other theoretical procedures. Observed phenomena are interpreted in terms of high-frequency approximation techniques.

6154 Series 60, Issue 249 (Report 92), "Analysis of the Image Plane Method for Measuring Radar Cross Sections," A. Olte, N7onr-29529, 2 Sep 59, (53:12), Unclassified, AD 230 400.

This report concerns extensions and changes to a CW image-plane system for measuring model cross-sections and scattering patterns and described in a previous report (Abstract 6151). Emphasis is largely on the equipment used, in particular the microwave bridge and the detection system, but attention is also given to explaining the oscillations in bridge detector voltage as the scattering object is pulled on the ground plane away from the illumination source. The range and working accuracy of the technique are compared with those of the Doppler technique, the pulse technique, and the CW full-space technique.

6155 Series 60, Issue 252 (Report 95), "Back Scattering from Cones," G. August and D. J. Angelakos, N7onr-29529, 22 Sep 59, (22:8), Unclassified, AD 230 508.

Backscatter cross-sections were measured for three right-circular cones in the resonance region; results given here are more accurate than those in an earlier report (Abstract 6149). The measurements were made as a function of aspect angle between incident radiation and cone axis at 9.3 Gc, using the image-plane method. The cones all had an apex angle of 15°, and had base diameters of 2λ, λ, and $\lambda/2$. A 4.5-inch copper sphere served as a reference target.

6156 Series 60, (Quarterly Progress Reports), Nonr-222(74), (53), (54), and (57), Unclassified.

Progress Report	Date	Pages:Refs.	AD. No.
28	30 Apr 60	20:9	237 676
29	31 Jul 60	22:9	243 155

These reports comprise short progress summaries of a number of projects, three of which pertain to radar reflectivity: (1) backscattering from cones (see Abstract 6157); (2) scattering from multiple targets (see Abstract 6158); and (3) scattered fields from anisotropic media. The multiple-target project involved theoretical and experimental investigation of scattering from two spheres using image-plane techniques. Broadside and end-fire illumination aspects were considered at 9.3 Gc for two 3-inch-diameter hemispheres. The third project investigated scattering from a ferrite cylinder between two parallel metal planes.

UNIVERSITY OF CALIFORNIA, ELECTRONICS RESEARCH LABORATORY (CONT.)

6157 Series 60, Issue 300 (Report 110), "Back-Scattering from Dielectric Cones," C. Y. Pon and D. J. Angelakos, Nonr-222(74), 26 Jul 60, (37:6), Unclassified, AD 245 163.

A highly accurate image-plane method was used to measure the backscatter cross-sections of a family of right-circular dielectric cones of finite dimensions. Cones having an apex angle of 15° and base diameters of 0.49λ, 0.79λ, and λ, and with relative dielectric constants of 5, 10, 15, and 20 for each diameter, were measured at 9.3 Gc. Results show a considerable difference between the dielectric cones and comparably sized metal cones. More lobes are observed for the dielectric cones as well as a reflection for the nose-on aspect which exceeded that for base-on in some instances.

6158 Series 60, Issue 313 (Report 116), "Electromagnetic Back Scattering from Multiple Spheres," N. Kumagai and D. J. Angelakos, Nonr-222(74), 1 Sep 60, (47:19), Unclassified, AD 247 431.

This is a brief historical review of theoretical and experimental work on multiple scattering by arrays of infinite and finite elements. Some of the findings are extended and applied to monostatic scattering by two- and three-sphere arrays for broadside and end illumination. The investigation included both theoretical and experimental procedures; measured and calculated results agreed quite closely.

6159 Series 60, Progress Report 30 (Quarterly Progress Report), Nonr-222(74), Nonr-222(53), and Nonr-222(57), 31 Oct 60, (23:1), Unclassified, AD 250 774.

Numerous research efforts are briefly summarized. Those pertinent here deal with backscattering from cones, scattering from multiple targets, scattering from gyrotropic media, and diffraction and scattering from a large conducting sphere.

6160 Final Technical Report, Nonr-222(74), 31 Mar 61, (16:3), Unclassified, AD 255 315.

The pertinent material in this report is limited to abstracts of several Electronics Research Laboratory reports pertaining to scattering and antennas. Included are abstracts of "Backscattering from Dielectric Cones" (Abstract 6157), and "Electromagnetic Backscattering from Multiple Spheres" (Abstract 6158).

6161 Series 60, Issue 365 (AFOSR-1186), "The Scattering of Microwaves from Multiple Spheres," K. A. Moe and D. J. Angelakos, AF 49(638)-1043, 2 Jun 61, (38:7), Unclassified, AD 265 754.

X-band backscattering by arrays of merged and unmerged spheres was measured on a CW, semi-infinite, ground-plane range. Two types of measurements were made for two- and three-sphere arrays having sphere-center separations ranging from about 20 cm to zero (the case in which the array merged into one sphere). The two measurement types entailed (1) pulling the various target arrays across the ground plane to obtain backscattering data for broadside and end-fire incidence, and (2) rotation of the arrays on the ground plane to measure approximate backscattering for all angles of incidence. A total of 24 scattering patterns are presented, along with a brief discussion and block diagram of the measurement system.

UNIVERSITY OF CALIFORNIA, ELECTRONICS RESEARCH LABORATORY (CONT.)

6162 Series 60, Issue 392 (AFOSR-1534), "A Variational Solution for the Scattering of Electromagnetic Pulses from a Cylinder of Finite Length," W. J. Welch, AF 49(638)-1043, 11 Aug 61, (27:6), Unclassified, AD 265 853.

Variational techniques are used to solve the problem of scattering of a plane electromagnetic impulse (a delta function) by a thin metallic cylinder of finite length. The current induced on the scatterer is assumed to be a damped sinusoid with oscillation frequency such that the cylinder is $\lambda/2$ long; the damping is due to radiation. Characteristic damping is also treated by variational methods. The time dependence of the far-field echo is plotted for two different cylinder diameters.

6163 Report 64-21 (AFOSR-64-1906), "On the Possibilities of Detection of Periodic Disturbances on a Rough Surface Using Radio Techniques," R. H. Clarke, Nonr-3656(11) and Grant AF-AFOSR 139-63, 29 May 64, (37:11), Unclassified, AD 448 493.

A simple approximation form is derived for electromagnetic wave reflection from a moving sinusoidal disturbance on both rough and still water to show that radar detection of such a disturbance is a practical possibility. The physical-optics approximation and Wiener Khintchine theorem are used in examining the angular power spectrum of the return. System implementation criteria are established; some experimental results at 3.0 cm demonstrate the validity of the analysis. Application to the detection of wakes of submarines is briefly mentioned.

UNIVERSITY OF CALIFORNIA AT LOS ANGELES

6164 Scientific Report 3 (AFCRC-TN-60-486), "Approximation of Light Scattering By Large Dielectric Spheres," D. S. Saxon, Z. Sekera, and D. Deirmendjian, AF 19(604)-2429, Jun 60, (-:4), Unclassified, AD 244 558.

(BD-4235) An approximate expression for the amplitude of the electric vector of radiation scattered by a large dielectric sphere is derived from an exact integral equation solution of Maxwell equations. The unknown electric and magnetic field vectors in the interior of the dielectric sphere are approximated by the assumption of rectilinear propagation of the incident wave through the sphere. The change in polarization is neglected; however, the phase along the ray is correctly evaluated. The final expressions for the amplitude of the electric vector of the scattered radiation can be reduced to the evaluation of only one integral, which is evaluated approximately for different domains of its variables, with the proper consideration of the errors of such approximations. The resulting expressions are then compared numerically with the exact Mie solution; the approximation is quite satisfactory in forward directions, and rather poor in wide-angle and backward scattering.

UNIVERSITY OF CANTERBURY (NEW ZEALAND)

6165 Scientific Report 3 (AFCRL-372), "The Latitude Dependence of Radar Meteor Shower Observations," C. S. L. Keay and C. Ellyett, AF 64(500)-6, 12 May 61, (10:14), Unclassified, AD 260 271.

Presents data showing the maximum hourly echo rates of meteor showers vs. declination, as observed from Christchurch and Adelaide, New Zealand, and Jodrell Bank, England. Narrow-beam, dual-antenna systems were used at each

UNIVERSITY OF CANTERBURY (NEW ZEALAND) (CONT.)

6165 (Cont.)

location. It is shown that most of the tables of meteor showers quoted in the literature give a false impression of the actual influx of meteors into the earth's atmosphere, due to lack of consideration of latitude dependence of echo rates.

UNIVERSITY OF CHICAGO

6166 Preliminary Copy, "Analysis of Ballistic Missile Interception Systems. Part II: Experiments on Satellite-Correlated RF Backscatter," L. S. Lerner, R. Baron, and D. Eastwood, AF 33(616)-5689, May 60, (-:24), Unclassified,

(BD-2106) Document not obtained.

6167 Addendum (Rough Draft), "Analysis of Ballistic Missile Interception Systems. Part II: Experiments on Satellite-Correlated RF Backscatter," L. Lerner, R. Baron, D. Eastwood, and H. Spector, AF 33(616)-5689, May 60, Unclassified.

(BD-2107) Document not obtained.

6168 "Project Whitetop," R. R. Braham, Jr., NSF Grant G-22419, 15 May 63, (36:3), Unclassified, AD 414 472.

Observations on a 3.3-cm radar were used with basic synoptic data in a series of field studies and statistical analyses of precipitation processes in the cumulus clouds of Missouri. In-cloud measurements of snow- and ice-pellet bulk densities and the effects of seeding with silver-iodide smoke and phloroglucinol are studied. Normalized height, temperature, and thickness distributions of first echoes, as well as distributions of echo growths, changes, and duration are some of the numerous graphical presentations. Characteristics of observed echoes and comparisons of echoes for seeded and not-seeded clouds are tabulated.

UNIVERSITY OF DAYTON RESEARCH INSTITUTE

6169 ASD-TDR-62-726, "Investigations of Optical Cross-Sections for Laser-Radar," W. R. Rambauske and D. L. Roettele, AF 33(616)-8169, 1 Mar 62, (50:-), Unclassified, AD 422 055.

A program originally aimed at broad consideration of laser radar was quickly narrowed to very limited study on certain aspects of target optical cross-section. Some general comments are made on geometrical and photometric considerations of cross-section for diffuse bodies of simple shape. Polar plots are given of experimental measurements of cross-sections for aluminum, copper, brass, and chalk cylinders and cones, using only conventional, non-coherent illumination. No experiments with laser illumination are described.

6170 Interim Report, "Theoretical and Experimental Reflection from Different Reflecting Bodies in the Far Field and Laser Beam Measurements with Respect to Intensity and Time," W. Rambauske, R. R. Gruenzel, and M. K. Barnoski, AF 33(657)-9014, Jun 63, (82:-), Unclassified, AD 423 641.

(RC-10464) No abstract available.

UNIVERSITY OF DAYTON RESEARCH INSTITUTE (CONT.)

6171 RTD-TDR-73-4148, "Coherent Optical Radar Parameters and Target Reflection," W. R. Rambauske, AF 33(657)-9014, Apr 64, (127:-), Unclassified, AD 600 272.

(RC-10814) Reflection of ruby laser pulses from artificial targets was investigated. The parameters of intensity distribution over the cross-section of a laser beam (having energy between 0.5 and 3 joules) and the time history of this intensity within one pulse (between 1/2 and 1 msec duration) were measured and evaluated in different distances for the ruby rod up to 75 m. Reflection characteristics for different standard geometrical bodies and different standard surface materials were derived experimentally and theoretically for incoherent white illumination and compared with laser illumination. Also studied was the change, due to the target's shape, in the time history of a single pulse after reflection from the target. This change when compared with the undistorted pulse from the rear of the ruby permits conclusions about the shape of the target.

UNIVERSITY OF GHANA

6172 Annual Summary Report 1 (AFCRL-62-560), "Equatorial Study of Irregularities in the Ionosphere," R. W. H. Wright, AF 61(052)-421, 28 Jan 62, (25:9), Unclassified, AD 289 404.

Summary of work on oblique HF transmissions received at Accra from Thule, Freiburg, and Washington. The main results are records of diurnal variations in signal strength, and of diurnal and seasonal variations in the sunset flutter rate.

6173 Annual Summary Report 2 (AFCRL-63-197), "Equatorial Study of Irregularities in the Ionosphere," B. R. Clemesha, G. S. Kent, J. R. Koster, and R. W. H. Wright, AF 61(052)-421, 1 Mar 63, (55:27), Unclassified, AD 410 983.

Three lines of study are described: (1) continued work on the sunset fading effect in oblique transmissions (see preceding abstract); (2) preliminary results of attempts to investigate F-region irregularities by measuring the fading rate of signals from satellites at spaced receivers; and (3) 18-Mc backscatter studies on size, height, motion, and diurnal variations of F-region irregularities.

UNIVERSITY OF ILLINOIS

6174 "Signals Reflected from the Moon," H. D. Webb, DA 36-039 SC-73163, Unclassified.

QPR	Date	Pages:Refs.	AD No.
3	30 Nov 57	11:0	159 746
7	30 Nov 58	25:0	210 440
8	28 Feb 59	15:0	217 850
9	31 May 59	15:0	220 795
10	31 Aug 59	59:20	226 578

This program involved the operation of a receiving system for signals reflected from the moon, and the analysis of the resulting data. The reports tabulated above deal very largely with experimental details of the instrumentation, and contain only very limited information relating to the reflectivity properties of the moon. Other reports from the series were not obtained.

UNIVERSITY OF ILLINOIS (CONT.)

6175 Report R-105, "Sea Clutter Spectrum Studies Using Airborne Coherent Radar III," B. L. Hicks, N. Knable, J. J. Kovaly, et al., DA 36-039 SC-56695, May 58, (31:9), Unclassified, AD 162 662.

Sea clutter was measured off the coast of New England with an airborne, coherent, X-band radar. Sea-state data derived from hindcasts and local observations provided a description of the sea surface at the time. Frequency B-scope displays, calculated from the observed data, indicated that the upwind edge of the clutter spectrum is smooth for all wind speeds observed, but that the downwind edge for Sea State 3 or above is broadened in an irregular fashion as a function of range.

The half-power bandwidth Δ_o of the coherent clutter spectrum was related to the sea state variables by the equation $\Delta_o = 11H_{1/3}\,T_m^{-1}$, where $H_{1/3}$ is the significant wave height, and T_m is the period corresponding to the maximum of the energy spectrum for the waves. This equation fitted the experimental data within about 10% for bandwidths in the range 2 to 5 knots and wind speeds in the range 8 to 19 knots. The bandwidth of the clutter was also found to be approximately proportional to the wind speed. Spectra from the rough seas were generally found to be broad and asymmetrical when the radar was looking upwind or downwind; these effects did not appear when the radar was looking crosswind. The scatterer responsible for the less steep side always moved downwind. Degree of asymmetry and spectrum bandwidth increase with sea roughness. Variation of clutter bandwidth with depression angle of the radar did not seem to be well defined or reproducible.

Note: For earlier work on sea clutter, see Abstracts 4310 and 4311.

6176 Technical Report 77, "Plane Wave Diffraction by Thick Dielectric Gratings, and Zone Phase Plates," H. A. Shubert, AF 33(657)-10474, Jun 64, (129:39), Unclassified, AD 603 026.

Diffraction of a plane electromagnetic wave by an infinite grating of dielectric bars is obtained by two methods. In one, the problem is formulated in terms of exact boundary-value equations which are solved numerically; the other involves an improved wave-optics method which accounts for multiple reflections, although it is less exact. Experimental work was carried out at 71 Gc to test the theoretical analyses. Experimental gratings made of polystyrene were about 50 by 50 wavelengths in size. In general, computed patterns agreed quite well with experimental tests. Results are used to make inferences about the action of zone plates, used as focusing devices, by considering the plates as generalized gratings and applying principles of improved wave optics.

UNIVERSITY OF MANCHESTER (GREAT BRITAIN)

6177 Scientific Report 1 (AFCRC-TN-57-240), "Meteor Trail Measurements by Radio Echo Detection Means," J. S. Greenhow, AF 61(514)-948, 30 Apr 57, (17:11), Unclassified, AD 133 818.

The reflection of radio waves from meteor trails is discussed; in particular, the process of evaporation of meteor atoms in relation to upper-atmosphere pressures and temperatures. Expressions are given which relate atmospheric pressure at the point at which a meteor produces its maximum ionization to

UNIVERSITY OF MANCHESTER (GREAT BRITAIN) (CONT.)

6177 (Cont.)

velocity and other physical properties of the meteor. It is shown that pressure, density, and temperature in the region 80 to 100 km above the earth can be measured by observing the heights of reflection of meteor echoes.

6178 Technical (Final) Report (AFCRC-TR-59-241), "Meteor Trail Measurements by Radio Echo Detection Means," AF 61(514)-948, 31 Oct 58, (29:17), Unclassified, AD 257 096.

This report is concerned with measuring upper-atmosphere densities and scale heights from radio echoes of meteor trails. Measurements of the mean heights at which meteors of different velocity burn away enables the air density to be determined. The widths of the height distributions for meteors in homogeneous velocity groups also give the scale height. Some measurements of density and scale height are presented; in particular the diurnal variation of atmospheric density is discussed.

6179 Technical Note 1 (AFCRC-TN-57-598), "Research on Moon Echo Phenomena," J. V. Evans, AF 61(514)-947, 30 Apr 57, (31:14), Unclassified, AD 133 650.

Data on radar reflection from the moon at 120 Mc was used to examine the electron content of the ionosphere by observing echo fading as it occurs simultaneously on two signals of slightly different frequency. Moon libration was observed to produce rapid fading of the echoes. It is suggested that such an effect could be used to examine the scattering mechanism of the lunar surface. Reflections occur mainly from a region near the center of the visible disk which is about one third the total radius.

6180 Technical (Final) Report (AFCRC-TR-59-184), "Research on Moon Echo Phenomena," J. V. Evans, AF 61(514)-947, 1 May 59, (30:23), Unclassified, AD 225 709.

Radar echo data are cited which indicate that the moon behaves as a quasi-smooth reflector at frequencies of 100 and 120 Mc. About 50% of the returned power is reflected from a region around the center of the visible disk having a radius of about one tenth the total radius. Observed fading was attributed to the magneto-ionic effect in the earth's ionosphere. Ionospheric electron content was measured; it is estimated that the ionosphere extends to about 1000 km above the earth's surface.

6181 Technical (Final) Report (AFCRL-TR-60-434), "Meteor Trail Measurements by Radio Echo Detection Means," J. E. Hall, AF 61(052)-206, 31 Aug 60, (23:24), Unclassified, AD 268 127.

This report is primarily concerned with the study of diurnal variations in scale height, density, and other atmospheric parameters for altitudes of about 95 km, using radio-echo observations of meteors. Included is a short treatment on the inter-relationships between the time constant of the radio-echo decay rate, the ambipolar diffusion coefficient, the scale height, and other parameters.

6182 Technical (Final) Report (AFCRL-1129), "Moon and Venus Radar. Passive Satellite Observations," AF 61(052)-172, Dec 60, (53:20), Unclassified, AD 271 741.

UNIVERSITY OF MANCHESTER (GREAT BRITAIN) (CONT.)

6182 (Cont.)

This report summarizes research at Jodrell Bank on a number of radar astronomy projects. The primary effort during this period was aimed at obtaining a radar return from Venus. Although return was not observed unitl April 1961, after the period of this report, equipment used in the 1961 observation, data desired, and analysis techniques that were ultimately applied are summarized in this document. Also treated is observation of Faraday rotation due to the ionosphere in moon-reflected signals. Day-to-day changes and the effects of magnetic disturbances are included. Scintillations are reported in the signals from Russian satellites in 1959 and 1960.

UNIVERSITY OF MIAMI, INSTITUTE OF MARINE SCIENCE

6183 Final Report (Report 8924-1; ML-59169), "Studies of the Evolution and Motion of Hurricane Spiral Bands and the Radar Echoes Which Form Them," H. V. Senn, H. W. Hiser, and E. F. Low, Cwb-9480, Aug 59, (65:28), Unclassified, AD 227 258.

Radar-echo vector motion in a stationary hurricane center was studied for 1573 echo trajectories from hurricanes Edna 1954, Connie, Diane, and Ione 1955, Audrey 1957, and Daisy and Helene 1958. Various aspects of hurricane structure as observed by radar, and the operational usefulness of spiral overlays for hurricane-center location, are discussed with the aid of 10.7-cm SP-1M and 3-cm CPS-9 radarscope photographs and graphic data. An improved radar model of hurricane-precipitation patterns is quantitatively examined and corroborated by the objective echo- and spiral-band data which have evolved from these studies. The echo speeds, averaging only about 40 knots and rarely exceeding hurricane velocities, were found to be relatively lower than those found by previous investigators. Preliminary results of several attempts to derive a mathematical model for spiral-band motion of echoes are presented. (See also next abstract.)

6184 Final Report (Report 8944; ML-60258), "Studies of the Evolution and Motion of Radar Echoes from Hurricanes," H. V. Senn, H. W. Hiser, and R. D. Nelson, Cwb-9727, Aug 60, (55:17), Unclassified, AD 249 479.

Additional data on hurricanes Debra, Judith, Item, and Easy showing that preliminary results from analysis of about half the data presented in Report 8924-1 (see preceding abstract) are verified, subject to important modifications in the region of the wall cloud. The echo-motion profiles which are presented for most individual storms compare favorably with those for an average hurricane. A study of the data on echo motion leads to several conclusions regarding methods of analysis; these are presented in the latter part of the report. Since attempts to mathematically describe echo- and spiral-band motion led to unrealistic results when the entire hurricane was used, it was concluded that a given description should usually be confined to one quadrant only, two at the most.

Carrot-shaped squall lines observed in three hurricanes are discussed with the aid of 10.7-cm SP-1M and 4.67-cm MPS-4 radarscope photographs. It is suggested that the motion of these squall lines may prove to be a reliable indicator of the impending completion of recurvature of the storms in which they appear.

UNIVERSITY OF MIAMI, INSTITUTE OF MARINE SCIENCE (CONT.)

6185 Final Report, Part I (Report 8824-4; ML-61394), "Weather Radar Receiving System," P. R. Ray, H. W. Hiser, and C. E. Steen, NO2(s)-60-6026-C, Nov 61, (84:11), Unclassified, AD 271 008L.

A new radar receiver system especially designed for meteorological applications is described. The system features, their functions and capabilities, and their present and proposed future utility are presented. Statistical results of a precipitation echo-height study based upon two years of data from an MPS-4 height-finder radar are presented and the application of these data to the problem of correcting for range attenuation is discussed. Radar observations of hurricane Donna, 1960, are described.

6186 Final Report (Report 8888-4; Report ML-62255), "Evaluation and Application of a Special Weather Radar Receiver System," H. W. Hiser, P. E. Norman, and C. E. Steen, NOw-61-0246-d, Mar 62, (61:12), Unclassified, AD 283 102.

Describes the modifications, improvements, and evaluation of a 10.7-cm SP-1M radar system, and summarizes the results of a two-year study of precipitation-echo heights observed with a 4.6-cm AN/MPS-4 height-finder radar in southern Florida. The effects of range attenuation upon RHI-scope measurements of echo tops are considered. An equation is given for computation of minimum detectable rainfall rates; computations for the AN/MPS-4 radar at ranges of 40 and 80 miles are discussed. The stretching of the precipitation-echo tops due to the vertical beamwidth is considered, with the conclusion that in the horizontal plane of the PPI beamwidth stretching can be ignored for most purposes. Also discussed are radar observations, synoptic weather data, and eyewitness accounts of the Miami tornado of 17 June 1959. It is reported that there is pronounced cyclonic motion in the hooked echo when the time-lapse film is viewed at normal motion-picture speed. Several PPI- and RHI-scope photographs of the tornado are presented.

6187 First, Second, and Third Interim Technical Reports, "Mesoscale Studies of Instability Patterns and Winds in the Tropics," H. P. Gerrish and H. W. Hiser, DA 36-039 SC-89111.

Interim Technical Report	Period Covered	Date	Page:Refs.	AD No.
First	1 May-31 Aug 62	Aug 62	25:9	289 808
Second	1 Sep-31 Dec 62	Apr 63	32:4	402 831
Third	1 Jan-30 Apr 63	Jul 63	30:8	414 579

This series of reports covers three concentrated case-studies of winds and echo movement observed by a 10.7-cm SP-1M radar and a 4.6-cm MPS-4 radar in southern Florida. The synoptic situation and the winds-aloft charts for each case are discussed in detail. Comparisons between mean echo motion and upper-air winds at grid points were based on streamline and isotach analysis.

In the First Report, streamline analysis indicates high-speed waves of short wavelength moving through the echo pattern at speeds of 50 to 100 knots. It is suggested that the convergent and divergent portions of these waves may trigger the growth and decay of clouds as they pass through an area. Radar precipitation echoes appeared to move most nearly with low-level winds, in particular the 5000-ft wind. It is reported that mean-layer winds were not verified as well as were the winds at specific levels, and that knowledge of the vertical extent of the echoes did not appear to improve the verifications.

UNIVERSITY OF MIAMI, INSTITUTE OF MARINE SCIENCE (CONT.)

6187 (Cont.)

The Second Report is similar to the first but gives particular attention to the translational motion of certain specific echoes and cells. Space-smoothed translational motion of precipitation echoes in this study most nearly represented the wind flow at 10,000 ft. An analysis of cloud cover as seen by the Tiros III satellite is also included. The echo motions studied in the Third Report agree best with the 3,000- 23,000-ft mean layer wind. Preliminary results on an echo-height study of certain mesoscale waves in the easterlies are also included. Isopleths on the echo-height maps appeared to be oriented in alternating bands of maximum- and minimum-height values. For all periods analyzed, there was a tendency for maximum-height bands to be oriented along, or immediately to the rear of, the axis of the surface waves. These results essentially suggest that a well-known classical cloud pattern described by Riehl for synoptic-scale waves in the easterlies is valid on the mesoscale as well.

6188 Final Report (Report 8982; ML-62361), "Radar Hurricane Research," H. V. Senn, H. W. Hiser, and J. A. Stevens, Cwb-10198, Sep 62, (109:18), Unclassified, AD 291 185.

The small-scale motion of the radar hurricane center is examined for hurricanes Ione 1055, Helene 1958, Debra 1959, Donna 1960, and Carla 1961, in an attempt to show the relationship between such motion and that which is actually reported and used operationally. Maps of eye-center movement and graphs of the speed characteristics are given for each storm. Echo vectors relative to the storm center are presented for 3805 traced echoes of hurricane Donna as photographed on 4.6-, 10-, 10.7-, and 23-cm radars. It is reported that echo density is greatest in the region of greatest inward motion, and least in the region having the greatest outward echo motions. A study of echo lifetimes in Donna showed that at ranges near 75-100 nmi echoes generally exist much longer (average about 45 minutes) than at greater ranges (an average of 30 minutes at 150 nmi). Distribution of crossing angle, and total, radial, and tangential echo-motion components are presented graphically for various storm speeds, quadrants, and ranges from the center. These data are then compared with similar data from earlier storms. (See also next abstract.)

6189 Final Report (Report 8251; ML-63470), "Radar Hurricane Research," H. V. Senn, J. A. Stevens, and H. W. Hiser, Cwb-10507, Sep 63, (75:23), Unclassified, AD 421 622.

The state of the radar art, in particular limitations in size, weight, and power requirements for airborne equipment, is examined theoretically in an attempt to determine optimum parameters for airborne weather-reconnaissance radars. Described here are the characteristics of a combined 5- and 3-cm radar, which seem to be optimum for existing and future weather-reconnaissance data-gathering missions. In addition to the equipment studies, analysis of the echo motion about Hurricane Donna on 9 and 10 September 1960 has been continued. It has been found that the night-time echoes move slightly slower than those in the daytime, and that land echoes move faster than over-water echoes. Comparisons of echo and wind kinematics produced significant relationships which varied from quadrant to quadrant. For each quadrant the fraction of echoes, number of echoes, speed, and crossing angle are plotted vs. range for over-land and over-water conditions, and also for night and day conditions. (See also next abstract.)

UNIVERSITY OF MIAMI, INSTITUTE OF MARINE SCIENCE (CONT.)

6190 Final Report (Report 8834-1; ML-64314), "Radar Hurricane Research," H. V. Senn and J. A. Stevens, Cwb-10755, Aug 64, (76:23), Unclassified, AD 608 622.

Small-scale motion of radar hurricane echoes in Donna 1960 was observed on 3.2-, 4.6-, 10.4-, 10.7-, and 23-cm radars and studied in great detail. Echo speeds were found to vary sinusoidally with time, corresponding to a disturbance speed which varied inversely with range r_s from the storm center. The oscillations, which had an average period of about one hour, exhibited a phase lag proportional to r_s^2. Differences in echo motion inside and outside of spiral bands were studied in Carla 1961, and motions of spiral bands in Donna and Carla were studied and found to be comparable. Spiral-band and squall-line motions in hurricanes Debra 1959, Donna 1960, and Helene 1958 were studied and related to hurricane movement, yielding a possible method of predicting the motion of hurricanes when squall-lines are visible on radar. An observation of a precipitation-free radar sea-breeze front or thin band which became a part of a spiral band in hurricane Ginny is included in the appendix.

UNIVERSITY OF MICHIGAN, INSTITUTE OF SCIENCE AND TECHNOLOGY

6191 Report 2749-7-T, "Silver-Coating Glass Yarn," F. A. Reiss, AF 33(616)-5522, May 59, (11:0), Unclassified, AD 216 450.

Description of a technique for silver-coating glass yarns for use as radar reflectors. The process differs from conventional chemical silvering methods in that the reduction is carried out without a reactor vessel; it was designed to place a continuous, adherent coating of silver on nonconducting substrates such as glass yarn or nylon.

6192 Report 3709-10-T, "Sampling from a Rayleigh Distribution," E. Taft, AF 33(616)-7391, Nov 61, (12:2), Unclassified, AD 266 355.

A table of exact values of sampling distribution for a Rayleigh population is presented for use in solving certain radar problems. A rationale and procedure are given for obtaining the values, which utilized cumulated terms of the Poisson exponential binomial limit and of standard chi-square tables.

6193 Report 3709-11-T, "A Variational Principle Simplified," C. M. McDowell, AF 33(616)-7391, Dec 61, (61:12), Unclassified, AD 269 254.

The mathematical tools needed in the variational formulation of electromagnetic boundary-value problems are given; these include calculus of variations, Green's function for the scalar Helmholtz equation, tensor analysis, and dyadics. The variational technique is applied to scattering problems, and an integral equation and a stationary expression are developed for handling them. Good training in mathematics and electromagnetic theory are required for ready digestion of the material. A representative though not all-inclusive list of references is given relating to the compiled material.

6194 Report 3709-17-T, "A Variational Formula for the Scattering from N Conductors," C. M. McDowell, AF 33(616)-7391, Dec 61, (17:4), Unclassified, AD 268 597.

UNIVERSITY OF MICHIGAN, INSTITUTE OF SCIENCE AND TECHNOLOGY (CONT.)

6194 (Cont.)

An integral formula is obtained in which the electric field scattered from N perfectly conducting obstacles (in the far-field region) is given in terms of a quantity called the vector amplitude. The backscatter cross-section of the N obstacles is given in terms of the vector amplitude, and a stationary, scale-invarient formula for the vector amplitude is derived. The backscatter cross-section is then given in terms of the stationary expression of the vector amplitude; the far-scattered field can be obtained similarly. The methods are adaptable to digital-computer analysis. Application to the calculation of backscatter from stranded conductors such as rope is mentioned.

6195 Memorandum 2900-30-R, "Some Difficulties of the Radar-Color Technique," B. Levy and E. E. Sellers, Jun 59, (7:0), Unclassified, AD 218 159.

A brief analysis of the possibility of detecting man-made metallic objects with a combat surveillance radar by means of their resonant properties. For grazing incidence with targets on the terrain surface, examination of the signal-to-clutter ratio (S/C) for reasonable wavelength and target sizes seems to show that the variation of target cross-section due to resonance is likely to be small compared to random fluctuations in the other factors contributing to S/C. It is concluded that the technique is of limited utility.

Ed: A sketchy argument is presented, based on some questionable assumptions; the conclusions may, however, still be correct.

UNIVERSITY OF MICHIGAN, RADIATION LABORATORY

6196 Report 2591-2-T (Scientific Report 2; AFCRC-TN-57-791), "Studies in Radar Cross Sections XXV. Diffraction by an Imperfectly Conducting Wedge," T. B. A Senior, AF 19(604)-1949, Oct 57, (71:19), Unclassified, AD 133 746.

The problem of diffraction of a plane electromagnetic wave by an imperfectly conducting wedge is solved subject only to the physical approximation implied by the usual impedance boundary conditions imposed on the faces of the wedge. The method leads to a difference equation for a function related to the Laplace transform of the field with respect to radial distance from the edge. The differential equation is solved exactly to give an expression for the total field valid for any angle of wedge. Several specific examples are solved to illustrate the method. The diffraction field for an imperfectly conducting half plane is solved by this method and compared with the field obtained with the Wiener-Hopf technique; the results are identical. The method is then applied to the imperfectly conducting wedge for particular wedge angles of $3\pi/2$ and $2\pi/3$. While the incident wave has been restricted to be an H-polarized wave in solving the above examples, the method can easily be applied to more general types of incident field.

6197 Report 2591-3-T (Scientific Report 3; AFCRC-TN-58-350), "Studies in Radar Cross Sections XXVI. Fock Theory," R. F. Goodrich, AF 19(604)-1949, Jul 58, (52:16), Unclassified, AD 160 790.

The Fock theory is applied to the scattering of a plane electromagnetic wave by a conducting surface which is smooth, convex, and of characteristic dimensions which are large with respect to λ. The heart of the theory lies in the physical argument which describes the field in the region of the shadow boundary in terms of a parabolic differential equation. Four specific problems are solved

UNIVERSITY OF MICHIGAN, RADIATION LABORATORY (CONT.)

6197 (Cont.)

to illustrate the method. The two-dimensional problem of scalar scattering from a circular cylinder is examined, and the field induced on the surface is calculated from Fock theory. A comparison of the Fock field with that calculated from the asymptotic form of the series solution for ka = 12 shows extremely close results. The generalized method is then applied to compute the field induced on an elliptic cylinder by an incident plane wave. The Fock field is compared with results from experimental data, once again showing very close agreement. The remainder of the report is concerned with the three-dimensional problems of scattering from a sphere and from a cone. It is shown that the Fock theory is applicable to any separable boundary-value problem. The asymptotic form of the special functions associated with these separable boundary-value problems may be found more easily if one assumes the Fock solution is the desired one.

6198 Report 2713-1-F, "Studies in Radar Cross Sections XXVII. Calculated Far Field Patterns from Slot Arrays on Conical Shapes," R. E. Doll, R. F. Goodrich, R. E. Kleinman, et al., AF 33(038)-28634 and AF 33(600)-36192, Feb 58, (115:17), Unclassified, AD 154 990.

The object of this report was to determine a method whereby a radome-dish antenna on a nosecone could be replaced by arrays of slots. This problem is related by the reciprocity theorem to the problem of determining the radar cross-section, since the current distribution on the nosecone is determined. The pattern of a single slot on a conical surface is determined, and a method is devised for computing the pattern for a given array of slots. In Appendix A, this method is applied to a 65-slot array for a given set of pattern parameters. The array patterns are computed and then optimized to satisfy the design criteria. Experimental data are presented for two conical cuts, and compared with calculated data, with excellent agreement. Appendix B deals with the problem of determining the field scattered by the tip of the nosecone. In Appendix C, the current distribution required on the conical surface of the nosecone to duplicate the far-field pattern of an ideal parabolic dish is computed. The instrumentation of this computed distribution on a conical surface would be extremely difficult.

6199 Report 2673-1-F (RADC-TR-58-73), "Studies in Radar Cross Sections XXVIII. The Physics of Radio Communication Via the Moon," M. L. Barasch, H. Brysk, B. A. Harrison, et al., AF 30(602)-1725, Mar 58, (86:31), Unclassified, AD 148 748.

An investigation into the possibility of communicating between points on the earth's surface via the moon. The first consideration is to determine the properties of the moon as a parasitic antenna. By applying the far-field criterion (minimum far-field range of $2D^2/\lambda$, where D is the linear dimension of the aperture, in this case the moon's diameter) it is shown that at the lowest wavelength which will penetrate the ionosphere, the moon must be considered to be in the near zone. Available data on moon echo seems to indicate that the moon's surface can be considered as quasi-smooth. Examination of the pulse return at several different frequencies reveals a sharp rise in the leading edge of the pulse, indicating that the return is largely due to specular reflection upon which relatively small

UNIVERSITY OF MICHIGAN, RADIATION LABORATORY (CONT.)

6199 (Cont.)

fluctuations are imposed. The echo data were also used to determine the electromagnetic characteristics of the moon's surface. Next, the propagation constants of cislunar space are examined in detail. Faraday rotation in the ionosphere and scattering by low-density meteor trails is considered. Suggested parameters for a pulsed FM communication system are outlined.

Note: A two-page supplement (AD 211 053) modifies slightly some of the conclusions.

6200 Report 2591-4-T (Scientific Report 4; AFCRC-TN-58-351), "Studies in Radar Cross Sections XXX. The Theory of Scalar Diffraction with Application to the Prolate Spheroid," R. K. Ritt and N. D. Kazarinoff, AF 19(604)-1949, Aug 58, (45:21), Unclassified, AD 160 791.

It is shown that the inhomogeneous wave equation, $\nabla^2 u - u_{tt} = \rho\, e^{i\omega t}$, with prescribed initial conditions and subject to outer boundary conditions on a smooth closed surface, has a solution of the form $v(x,t)\, e^{i\omega t}$, and that $\lim_{T\to\infty} T^{-1} \int_0^T v(x,t)dt$ is given by the formula $\Phi(x) = \lim_{s\to 0} \Phi(x,s)$, where $\Phi(x,s)$ is the solution of $\nabla^2\Phi + (\omega - is)^2\Phi = \rho$, subject to the same boundary conditions as u, and which is square-integrable in the exterior region. The theory of analytic resolvents is applied to represent the solution of this equation as a contour integral. In the case of the sphere, this integral is the same as the representation obtained by use of the Watson transform. For axially symmetric scattering of a plane wave by a prolate spheroid, the integral can be evaluated in the shadow region as a residue series represented as a sum of creeping waves. The attenuation of the creeping waves is shown to be proportional to $\omega^{1/3}R^{-2/3}$, where R is the radius of curvature at the tip; this contradicts several previously held theories.

6201 Report 2778-2-T (RADC-TN-59-105), "Studies in Radar Cross Sections XXXI. Diffraction by an Imperfectly Conducting Half-Plane at Oblique Incidence," T. B. A. Senior, AF 30(602)-1853, Feb 59, (35:4), Unclassified, AD 212 611.

The exact solution is obtained for the problem of a plane wave incident at an oblique angle on a half plane of large but finite conductivity. The analysis requires the solution of coupled Wiener-Hopf integral equations for the Fourier transforms of the four current distributions. Resulting expressions for the fields are exact, subject only to the physical approximation implied by the impedance boundary conditions. It is shown that the technique employed to determine oblique-incidence solutions for perfectly conducting bodies cannot be used when the conductivity is finite; indeed, all the field components produced in this way are in error. The analysis has not suggested a general technique for treating finite conductivity, but the particular solution obtained can be applied to other scattering problems such as the coastal refraction of radio waves.

6202 Report 2778-3-T (RADC-TN-59-106), "Studies in Radar Cross Sections XXXII. On the Theory of the Diffraction of a Plane Wave by a Large Perfectly Conducting Circular Cylinder," P. C. Clemmow, AF 30(602)-1853, Feb 59, (32:19), Unclassified, AD 212 612.

UNIVERSITY OF MICHIGAN, RADIATION LABORATORY (CONT.)

6202 (Cont.)

Investigation of plane-wave diffraction by a large circular cylinder. A Fourier integral representation was used for the fundamental approach, and useful integral expressions for the radiation part of the scattered field and for the total scattering cross-section were derived through Fourier techniques. Three devices are proposed for overcoming convergency difficulties which arise in the derivation of integral expressions for the field at a finite distance from the axis of the cylinder. One section relates the behavior of the current on the cylinder to that of the field in space. The case in which the magnetic vector is parallel to the axis of the cylinder is also briefly discussed, and finally the new model is compared with others.

6203 Report 2778-4-T (RADC-TN-59-163), "Studies in Radar Cross Sections XXXIII. Exact Near Field and Far Field Solution for the Back Scattering of a Pulse from a Perfectly Conducting Sphere," V. H. Weston, AF 30(602)-1853, Apr 59, (55:11), Unclassified, AD 215 486.

In this theoretical study, a pulse of planar electromagnetic radiation having a duration τ is incident on a perfectly conducting sphere of radius a; the radiation consists of a sinusoidal wave of frequency ω. The variation of the pulse of backscattered energy as a function of time is investigated. Interest is focused on any possible tail of the return pulse, in particular, the dependence of the tail on sphere size. It is found that for a given frequency ω, sphere size will affect the form of the tail on the return pulse. At resonant frequencies, there is a significant tail, while at high frequencies the tail is negligible. For ka>1, the initial part of the tail (i.e., in the time interval $\tau < T < \tau + 2a/c$ (where c is the velocity of light) will be on the order of 1/ka of the head of the return pulse. The remainder of the tail, i.e., $T > \tau + 2a/c$, decays quite rapidly. A portion of the tail is attributed to a creeping-wave contribution to the return.

6204 Report 2778-5-T (RADC-TN-59-107), "Studies in Radar Cross Sections XXXIV. An Infinite Legendre Integral Transform and Its Inverse," P. C. Clemmow, AF 30(602)-1853, Mar 59, (28:6), Unclassified, AD 212 613.

In diffraction of monochromatic waves by circular cylinders and spheres, the "classical" series solution becomes intractable as the radii of the obstacles increase much beyond a wavelength. A solution can be obtained for this case from contour-integral representations in which the variable of integration is the separation constant ν. In the case of the sphere, the separable solution of the wave equation in spherical polar coordinates leads to a function satisfying Legendre's equation. Thus it is desirable to determine the inverse of an infinite integral transform in which the kernel is a Legendre function whose behavior for values of the angular variable θ is in some sense analogous to $\exp(i\nu\theta)$. An inversion formula is stated and confirmed rigorously for the particular case where the original function is a rectangular pulse, and heuristically for the general case by an appeal to the delta-function concept. The standard series expansion in terms of Legendre polynomials is recovered when the original function is even and of period 2π in θ. A methodical derivation of the transform relations is given in an appendix.

UNIVERSITY OF MICHIGAN, RADIATION LABORATORY (CONT.)

6205 Report 2778-6-T (RADC-TN-59-164), "Studies in Radar Cross Sections XXXV. On the Scalar Theory of the Diffraction of a Plane Wave by a Large Sphere," P. C. Clemmow, AF 30(602)-1853, Apr 59, (39:15), Unclassified, AD 215 487.

Scalar diffraction by a large sphere is here treated by a method analogous to that used for the cylinder in Report 2778-3-T (Abstract 6202). The problem is solved with boundary condition either $U = 0$ or $\partial U/\partial r = 0$, where U is the wave function of the total field; it is carried out by means of a technique described in Report 2778-5-T (preceding abstract). Useful integral representations for the field, previously obtained by other means, are re-derived. The radiation part of the scattered field is first discussed including the special cases of forward- and backscattering, the former of which yields the total scattering cross-section; subsequently, the field at a finite distance is considered.

6206 Report 2871-3-T (AFCRC-TN-59-955), "Studies in Radar Cross Sections XXXVI. Diffraction of a Plane Wave by an Almost Circular Cylinder," P. C. Clemmow and V. H. Weston, AF 19(604)-4993, Sep 59, (47:10), Unclassified, AD 232 129.

The two-dimensional problem of an E-polarized plane wave incident on a perfectly conducting cylinder of almost circular geometrical cross-section is treated. The maximum deviation of the perimeter of the cross-section from a strict circle is regarded mathematically as an infinitesimal quantity whose second and higher powers are neglected. In the body of the paper infinite Fourier-transform techniques are used to solve the problem, but an analysis involving a Watson transformation is given in an appendix. Various Bessel function relations are required, some of which are derived in appendices. Attention is largely confined to the case in which the mean radius is large compared to a wavelength. In particular, initial terms of asymptotic expansions in inverse powers of the ratio of mean radius to wavelength are obtained, both for the specular and for the creeping-wave contributions to the far field. It is shown that the former contribution is in agreement with that derived by the Luneburg-Kline method, and the latter with the prescription proposed by Keller.

6207 Report 2871-4-T (AFCRC-TN-60-106), "Studies in Radar Cross Sections XXXVIII. Non-Linear Modeling of Maxwell's Equations," J. E. Belyea, R. D. Low, and K. M. Siegel, AF 19(604)-4993, Dec 59, (39:6), Unclassified, AD 232 130.

Linear modeling is of very limited utility in determining the cross-sections of ablating nosecones and in studying scattering from plasmas. (See also Abstracts 6212, 6228, and 6230.) In this report, several non-linear models of equations of mathematical physics are presented. Non-linear modeling is accomplished for the simple harmonic oscillator, the non-linear spring equations, Euler's equation, the Boltzmann equation, a general non-linear oscillator equation, and the scalar wave equation. A method is included which shows how to model Maxwell's equations non-linearly by utilizing the non-linear modeling of the scalar equation. It appears that certain experiments previously considered beyond our present capabilities will now become feasible.

6208 Report 2500-2-T, "Studies in Radar Cross Sections XL. Surface Roughness and Impedance Boundary Conditions," R. E. Hiatt, T. B. A. Senior, and V. H. Weston, Jul 60, (96:-), Unclassified.

Note: This report was not obtained.

UNIVERSITY OF MICHIGAN, RADIATION LABORATORY (CONT.)

6209 Report 2886-1-T (AFCRL-TN-60-649), "Studies in Radar Cross Sections XLI. Part I. Pressure Pulse Received Due to an Explosion in the Atmosphere at an Arbitrary Altitude," V. H. Weston, AF 19(604)-5470, Aug 60, (60:15), Unclassified, AD 245 554.

A study of a pressure pulse produced by an explosion at various heights in the atmosphere, this report contains no material directly applicable to the study of radar cross-sections or scattering theory.

Note: Studies in Radar Cross Sections XLII is entitled "On Microwave Bremsstrahlung from a Cool Plasma" and does not pertain directly to reflectivity.

6210 Report 2764-6-T, "Studies in Radar Cross Sections XLIII. Plasma Sheath Surrounding a Conducting Spherical Satellite and the Effect on Radar Cross Section," Kun-Mu Chen, DA 36-039 SC-75041, Oct 60, (40:5), Unclassified, AD 250 805.

In this theoretical study on the plasma sheath surrounding a satellite, a conducting sphere is assumed to move with velocity 8 km/sec through a dilute, electrically neutral atmosphere simulating an altitude of 500 km. Density distributions are found for positive ions and for electrons in the vicinity of the satellite, and the change in the effective cross-section of the satellite is deduced. On the basis of a rough numerical calculation for a satellite of radius 1 m viewed with a wavelength of 15 m, it is concluded that there will be a very strong specular contribution to the cross-section normal to the satellite velocity, but at other aspects the cross-section will be little changed.

6211 Report 3648-3-T (Scientific Report 3; AFCRL-65), "Studies in Radar Cross Sections XLIV. Integral Representations of Solutions of the Helmholtz Equation with Application to Diffraction by a Strip," R. E. Kleinman and R. Timman, AF 19(604)-6655, Feb 61, (121:25), Unclassified, AD 253 052.

A class of solutions for the two dimensional Helmholtz equation is derived and used to find a closed integral form for the field diffracted by a strip. Exact methods of solving diffraction problems are briefly examined and compared with the present approach. A class of solutions of the Helmholtz equation is then obtained in the form of an integral with a particular kernel and an arbitrary weighting function. These solutions are used to find new integral representations of combinations of cylinder functions, with particular attention paid to the case of line sources. Finally a double-integral representation of the Green's function for a line segment is obtained. The case of a semi-infinite line segment is considered and the classical half-plane result is recast into double integral form. It is then demonstrated that the corresponding Green's function for the strip is essentially the equivalent form in elliptic coordinates.

6212 Report 2871-6-F (Final Report; AFCRL-40), "Studies in Radar Cross Sections XLV. Studies in Non-Linear Modeling-II," J. E. Belyea, J. W. Crispin, Jr., R. D. Low, et al., AF 19(604)-4993, 31 Dec 60, (94:20), Unclassified, AD 257 186.

A collection of studies on non-linear modeling performed during 1960, this report includes a discussion of the generality of such modeling which reveals that all second-order ordinary differential equations arising from a conservative system can be locally modeled in a non-linear manner. Also considered are the problem of modeling the scalar wave equation in n-dimensions and the effect of

UNIVERSITY OF MICHIGAN, RADIATION LABORATORY (CONT.)

6212 (Cont.)

experimental errors on the applicability of non-linear modeling. The problem of modeling a scalar scattering problem for one geometric configuration into one for a second geometric configuration is begun. Two cases are considered: (1) modeling a scalar scattering problem for an elliptical cylinder by one for a circular cylinder, and (2) modeling prolate spheroid problems into sphere problems. (See also Abstracts 6207, 6228 and 6230.)

6213 Report 3648-4-T (Scientific Report 4; AFCRL-787), "Studies in Radar Cross Sections XLVI. The Convergence of Low Frequency Expansions in Scalar Scattering by Spheroids," T. B. A. Senior, AF 19(604)-6655, Aug 61, (143:7), Unclassified, AD 269 585.

The exact solution is known for the scalar problem of plane-wave diffraction by a spheroid, and at low frequencies the expression for the far-field amplitude can be expanded in a series of increasing powers of ka, where 2a is the interfocal distance. This is the Rayleigh series; it is convergent for sufficiently small values of ka. In order to determine the range of frequencies for which this expansion is applicable, an essential factor is the radius of convergence; this report is devoted entirely to the calculation of this quantity. Attention is concentrated on the case in which the plane wave is incident nose-on, and the radius of convergence is obtained as a function of the length-to-width ratio for prolate and oblate spheroids, hard as well as soft. For other angles of incidence it can be shown that the radius is not greater than this, and in most instances it would appear to be the same.

6214 Report 3648-1-T (Scientific Report 1; AFCRL-62-40), "Studies in Radar Cross Sections XLVII. Diffraction and Scattering by Regular Bodies - I: The Sphere," R. F. Goodrich, B. A. Harrison, R. E. Kleinman, and T. B. A. Senior, AF 19(604)-6655, Dec 61, (135:48), Unclassified, AD 273 006.

The first in a series (see following two abstracts) aimed at summarizing available information about the scattering properties of selected bodies of simple shape, this report deals entirely with the diffraction of electromagnetic energy by a sphere. Several forms of solution, both exact and approximate are examined. The first is the Mie solution, and a table listing available Mie theory functions is presented. The low-frequency or Rayleigh solution is then obtained by two different methods. In the first, the series is obtained by expanding the various terms in the Mie solution, but in the second the low-frequency expansion is obtained directly without any explicit reference to the Mie result. Some representative bistatic cross-section curves for a perfectly conducting sphere are included. In addition the backscatter cross-section is given as a function of ka for the perfectly conducting sphere. The high-frequency scattering behavior is investigated with an approach based on the Watson transform. Since this latter material does not appear in any standard reference, a relatively detailed exposition is given. In the final section, the physical-optics approach is applied to the sphere problem.

6215 Report 3648-2-T (Scientific Report 5; AFCRL-63-29), "Studies in Radar Cross Sections XLVIII. Diffraction and Scattering by Regular Bodies-II: The Cone, R. E. Kleinman and T. B. A. Senior, AF 19(604)-6655, Jan 63, (143:96), Unclassified, AD 407 557.

UNIVERSITY OF MICHIGAN, RADIATION LABORATORY (CONT.)

6215 (Cont.)

The second in a series summarizing available information about scattering properties of selected bodies of simple shape, this report deals with scattering by a perfectly conducting finite or infinite cone embedded in a homogeneous, isotropic medium. Consideration is also given to the corresponding scalar problem involving scattering of acoustic waves by hard and soft cones. Although recent investigations have revealed that the most vital scattering characteristic of the finite cone is its termination, a historical development of the problem is presented for both finite and infinite cones. A section is devoted to the exact formulation and solution of the problem of scattering by a cone. The relation between vector and scalar boundary value problems is examined, and it is pointed out that in some cases a single scalar function can be used to solve two meaningful physical problems, one scalar and one vector; one such case is treated in detail.

Existing expressions are listed for the scattering properties of semi-infinite cones with either plane-wave or point-source excitation. Various approximations are given, along with restrictions on their validity. Formulas are presented with a natural division of vector and scalar problems; the scalar formulas are further split according to Dirichlet and Neumann boundary conditions.

The backscatter cross-section of a finite circular cone for plane-wave incidence is also discussed; several different types of cone termination are considered along with the low-frequency behavior. The physical-optics method is used to derive the scattered field at high frequencies, and comments are included on the extension of high-frequency results into the intermediate-frequency range. Experimental data resulting from a literature search is summarized together with unpublished data known to the authors. Data and sources of data for scattering from the flat-backed cone, the cone-sphere, and other terminations are tabulated by investigator, measurement frequency, ka, and cone half angle.

6216 Report 3648-6-T (AFCRL-64-138), "Studies in Radar Cross Sections XLIX. Diffraction and Scattering by Regular Bodies III: The Prolate Spheroid," F. B. Sleator, AF 19(604)-6655, Feb 64, (229:88), Unclassified, AD 603 033.

The third in a series on electromagnetic and acoustical scattering by bodies of simple shape, this report deals with the prolate spheroid. Except for the case of a point dipole located at the tip of a spheroid, consideration is limited to problems where the source of energy is exterior to the scatterer. Principles and techniques are discussed to give a fairly comprehensive picture of the state of the art. The report is aimed at serving both as a reasonably complete and convenient guide to existing solutions and as a catalyst in development of new ones.

An analysis of the geometry of the prolate spheroidal coordinate system, including a detailed account of two of the most widely used systems, is followed by a largely verbal discussion of the methods and principles employed in the various solutions, including both exact and approximate categories. The essential approximations are tabulated first, including those which are frequency-restricted (both low and high), eccentricity-restricted, and those for weak scatterers; experimental and theoretical results are then discussed. An appendix contains an index to available numerical tables, which serves as a guide to the principal tables computed for the spheroid problem.

UNIVERSITY OF MICHIGAN, RADIATION LABORATORY (CONT.)

6217 Report 2500-3-T, "Measurement and Use of Scattering Matrices," J. W. Crispin, R. E. Hiatt, F. B. Sleator, and K. M. Siegel, Feb 61, (121:-), Unclassified.

Note: This report was not obtained.

6218 Report 2591-5-F (AFCRC-TR-59-179), "Final Report," K. M. Siegel, AF 19(604)-1949, Jul 59, (6:27), Unclassified, AD 225 015.

Aside from a very brief summary of a manual entitled, "A Theoretical Method for the Calculation of the Radar Cross-Sections of Aircraft and Missiles" (see next abstract), this report comprises only a listing of major efforts on the contract including references and reports.

6219 Report 2591-1-H (AFCRC-TN-59-774), "A Theoretical Method for the Calculation of the Radar Cross Sections of Aircraft and Missiles," J. W. Crispin, Jr., R. F. Goodrich, and K. M. Siegel, AF 19(604)-1949, Jul 59, (408:18), Unclassified, AD 227 695.

This document is one of the most useful references on cross-section calculation included in this bibliography. Although it was intended to serve as a handbook for calculating radar cross-sections of aircraft and missiles, the calculation procedures are outlined in detail and it is sufficiently comprehensive so as to be a useful source document for many aspects of cross-section calculation. The document summarizes several years of experience at the University of Michigan's Radiation Laboratory, and constitutes an excellent introduction to the general subject, as well as providing much specific reference data. Further details on many of the topics treated can be found in other Michigan reports, particularly the "Studies in Radar Cross Sections" series. The material in the text proper is organized as follows.

Following a short introduction, summarizing the basic mathematics of scattering, the sphere is examined. The harmonic-series solution of Mie is stated and an approximation derived for $ka \ll 1$. In the next chapter, the physical-optics approximation is treated for the sphere and for targets in general. Section 4 applies the preceding general discussion to a number of the simple shapes: ellipsoids, spheroids, truncated circular and elliptic cones, cylinders, thin wires, tori and wire loops, the ogive (including the truncated ogive and the ogive capped by a sphere), flat plates (rectangular, circular, and general), the tapered wedge, corner reflectors (and multiple scattering in general), and the paraboloid. The discussion is largely confined to the optics region. Section 5 examines bistatic scattering; the prolate spheroid is used as an example. The following theorem is proved: for $ka \to \infty$, the bistatic cross-section for transmitter direction $\vec{k}$ and receiver direction $\vec{n}$ is equal to the monostatic cross-section for the transmitter-receiver direction $\vec{k} + \vec{n}$ with $\vec{k} \neq \vec{n}$ for bodies which are sufficiently smooth. (Here $\vec{k}$ is a unit vector from transmitter to origin and $\vec{n}$ a unit vector from receiver to origin.) Section 6 considers the process of combining component cross-sections into a total cross-section for a complex target such as an aircraft; both random- and relative-phase summation is discussed. Section 8 illustrates the use of the preceding material by calculating the cross-sections of typical missile and aircraft shapes.

UNIVERSITY OF MICHIGAN, RADIATION LABORATORY (CONT.)

6219 (Cont.)

More than half the document is devoted to the following appendices.

Appendix A. "Complete Scattering Matrices and Circular Polarization Cross Sections," (70:18).

Topics include: scattering matrices; approach to the multiple-component body problem; independent cross-sections appropriate to multiple-component bodies; polarization effects and the physical-optics approximation; cross-polarization cross-sections of cylinders, wedges, and wire loops; and dihedral scattering.

Appendix B. "Far Field Scattering From Bodies of Revolution," (58:22).

Reprinted with slight revisions from a journal article (see Abstract 7096J), the discussion is divided into treatments for the Rayleigh region, the optics region, and the resonance region.

Appendix C. "Cross Sections of Corner Reflectors and Other Multiple Scatterers at Microwave Frequencies," (54:8).

The treatment includes monostatic cross-sections of square and triangular corner reflectors, and the bistatic cross-section of the square corner reflector. The discussion on other multiple scatterers includes scattering from curved surfaces treated by Fock's method (applied to a pair of spheres) and by the method of stationary phase (applied to the biconical reflector). Experimental data on corner reflectors is illustrated.

Appendix D. "Monostatic Radar Cross Section of the Elliptical Corner Reflector," (32:0).

A reprint of Appendix D of Report 2260-29-F (see Abstract 4319).

Appendix E. "Bistatic Radars and Forward Scattering," (18:6).

A paper presented by K. M. Siegel at the IRE meeting in Dayton, Ohio, on 13 May 1958. Forward scattering and cross-section are examined for bodies of arbitrary shape. It is concluded that for ka>>1, bistatic cross-sections in the forward direction will always be greater than the monostatic cross-section for convex targets.

Appendix F. "Power Spectra for Experimental Data," (10:5).

Basic quantities are defined and the Wiener-Khinchine relation is derived.

Appendix G. "Determination of Power Spectra from Theoretical Estimates of the Radar Cross Section," (13:0).

Aspect is presumed to remain fixed and frequency is changed by small percentages. One approach examines the spectrum of the cross-sections and another that of the square root of the cross-sections.

A final appendix tabulates the reports in the "Studies in Radar Cross Sections" series and related reports.

Note: Readers using this report should obtain a memo on Errata and Addenda for this report, issued by J. W. Crispin, Jr. at the University of Michigan on 8 Feb 1960.

UNIVERSITY OF MICHIGAN, RADIATION LABORATORY (CONT.)

6220 Report 2764-7-R, "Report of Major Event," W. E. Burdick and K. M. Siegel, DA 36-039 SC-75041, ARPA Order 120-60, 24 Jan 61, (-:8), Unclassified.

(BD-3146) It has been shown theoretically that the radar cross-section of an object moving at satellite altitudes and velocities is enhanced several orders of magnitude by the plasma sheath surrounding the object, and that this enhancement is aspect sensitive. This brief report compares predictions of this theory with measurements reported by Kraus. One of the most significant results is due to the satellite Sputnik III having its point of closest approach on one pass fall on the center of the antenna beam. In this instance, the enhanced burst pattern shows a very symmetric form and Kraus was able to calculate the cross-section of the satellite as on the order of 10^6 m^2.

6221 Report 2764-15-F (Final Report), "Investigation of Physical Model for Satellite Detection," R. J. Leite, DA 36-039 SC-75041, May 62, (18:-), Unclassified.

Note: This report was not obtained.

6222 Report 2871-1-T (AFCRC-TN-59-393), "Electromagnetic Scattering by High Density Meteor Trails," H. Brysk, AF 19(604)-4993, Jun 59, (24:5), Unclassified, AD 225 016.

The validity of approximations to scattering from low electron-density trails is first examined and shown to depend not only on the electron line density but also on the wavelength of observation and on the altitude of the trail. A model is developed for scattering from an overdense trail which corrects for absorption of the incident wave, but assumes that individual electrons scatter independently by the Compton process. Results are compared with the conventional approach which replaces the electron distribution by a metallic scatterer whose surface is the critical density contour. Calculations with non-Gaussian electron distributions are studied to clarify the physical interpretation.

6223 Report 2871-2-T (AFCRC-TN-59-394), "Scalar Diffraction by an Elliptic Cylinder," N. D. Kazarinoff and R. K. Ritt, AF 19(604)-4993, Jun 59, (23:-), Unclassified.

(BD-1268) Scalar scattering by a perfectly reflecting elliptic cylinder illuminated by waves from a line source parallel to the axis of the cylinder is discussed. The surface distribution in the shadow zone is calculated, and the creeping-wave representation for the scattered field in the shadow zone is derived. It is shown that results are applicable if and only if $R_o \omega \gg 1$, where R_o is the smallest radius of curvature on the cylinder and ω is the wave number.

6224 Report 2871-5-T, "Some Relations Between Potential Theory and the Wave Equation," D. A. Darling, AF 19(604)-4993, Dec 60, (42:-), Unclassified.

Note: This report was not obtained.

6225 Report 3544-1-T, "A Study of Lunar Thermal Emission," A. Giraud, Subcontract from Autometric Corp., Sep 60, (36:30), Unclassified, AD 253 471.

Values for the electromagnetic parameters of the moon's surface, based on results of radar investigations, are used to determine the thermal parameters of the surface.

UNIVERSITY OF MICHIGAN, RADIATION LABORATORY (CONT.)

6226 Report 3544-1-F, "Estimation of the Physical Constants of the Lunar Surface," M. Brunschwig, W. E. Fensler, E. F. Knott, et al., Nov 60, (34:-), Unclassified.

Note: This report was not obtained.

6227 Report 3648-5-T, "Studies in Nonlinear Modeling-V: Nonlinear Modeling of a Special Type," O. G. Ruehr, AF 19(604)-6655, Aug 62, (101:-), Unclassified, AD 292 106.

Note: This report was not obtained. See also next abstract.

6228 Report 4134-2-F (Final Report; AFCRL-746), "Studies in Non-Linear Modeling-III. On the Interaction of Electromagnetic Fields with Plasmas," Kun-Mu Chen, J. Meixner, D. Sengupta, et al., AF 19(604)-7428, ARPA Order 147, 31 Jul 61, (140:18), Unclassified, AD 267 391.

Results of an investigation of the interaction of electromagnetic fields with plasmas, including the development and use of appropriate non-linear modeling techniques. Broad topics treated include: (1) the plasma sheath formed by a moving or stationary plasma on an infinite plate; (2) the interaction of a high-intensity electromagnetic wave with a low-density plasma and with a weakly ionized gas; (3) the electrical conductivity of partially or fully ionized gases. (See also Abstracts 6207, 6212, and 6230.)

6229 Report 4386-2-F, "An Investigation of the Absorption of Electromagnetic Radiation by a Plasma of Sub-critical Density," A. Olte, M. L. Barasch, E. G. Fontheim, et al., AF 19(604)-8032, Feb 62, (99:-), Unclassified.

Note: This report was not obtained.

6230 Report 4405-1-F (Final Report; AFCRL-62-108), "Studies in Non-Linear Modeling-IV: Far Field Scattering by Simple Shapes at Low Frequencies," R. E. Kleinman, R. D. Low, and F. B. Sleator, AF 19(604)-8030, Feb 62, (34:16), Unclassified, AD 274 528.

An attempt at modeling the field scattered by a prolate spheroid with that scattered by a sphere to circumvent the problems associated with the known exact theoretical analysis. Three different methods of attack are described. Representing spheroidal functions in terms of spherical functions yields a solution which is not in an appropriate form. In the second approach, non-linear modeling is achieved by explicit derivation of the modeling function with modified assumptions. The third approach derives a linear modeling function shown to be an extrapolation from the case when two terms of a multipole expansion suffice to describe the spheroid field. A numerical example shows the applicability of both modeling functions to be severely limited for accurately describing the spheroidal field. (See also Abstracts 6207, 6212, and 6228.)

6231 Report 5246-1-F, "Radar Cross Section Studies of a Cone-Cylinder Model with and without Fins," R. E. Hiatt, Subcontract from Minneapolis-Honeywell, Aug 62, (12:-), Unclassified.

Note: This report was not obtained.

UNIVERSITY OF MICHIGAN, RADIATION LABORATORY (CONT.)

6232 Report 5391-1-F, "A Study of VHF Absorbers and Anechoic Rooms," R. E. Hiatt, E. F. Knott and T. B. A. Senior, NASr-54(L-1), Feb 63, (91:-), Unclassified.

Note: This report was not obtained.

6233 Report 5548-1-T (Scientific Report), "The Minimization of the Radar Cross Section of a Cylinder by Central Loading," Kun-Mu Chen and V. V. Liepa, AF 19(628)-2374, Apr 64, (99:5), Unclassified, AD 601 576.

Description of a program intended to develop a theory to explain the behavior of the cross-section of a cylinder with loading, and to determine the optimum loading. The presentation is divided into two parts: in the first, a center-loaded cylinder illuminated normally by a plane wave is considered and the basic theory of center-loading developed; in the second, the theory is generalized to cover plane-wave incidence at any arbitrary aspect angle. Only conducting cylinders less than 2λ in length with radius small compared to λ were considered. It was found that there exists an optimum impedance which gives zero broadside backscattering and very low return at other aspects for a resonant cylinder, while for an antiresonant cylinder the cross-section may be enhanced for other aspects. An expression for the optimum impedance is graphed as a function of cylinder dimension. Experimental checks at 1.088 Gc on this theory showed very good agreement.

For the obliquely illuminated cylinder, it was found that the induced current has symmetrical and anti-symmetrical components. The symmetrical component can be modified greatly by central loading but the anti-symmetrical component is not affected. It was found that optimum center-loading can reduce the cross-section of a resonant cylinder by more than 30 dB; however, the cross-section of an antiresonant cylinder can be reduced only in the broadside direction and the large cross-section it displays in the off-broadside direction is not reducible by center-loading. Multiple loading might prove more effective in the antiresonant case.

6234 Report 5548-2-T (Scientific Report 2; AFCRL-64-915), "Modification to the Scattering Behavior of a Sphere by Reactive Loading," V. V. Liepa and T. B. A. Senior, AF 19(628)-2374, Oct 64, (74:19), Unclassified, AD 609 903.

Investigation of electromagnetic scattering by a metallic sphere loaded with a circumferential slot in the plane normal to the direction of incidence. The slot is assumed to be of small but non-zero width with electric field constant across it; under this assumption the analysis of external field is exact. The field scattered in any direction is obtained by superposition of the field diffracted by an unloaded sphere and that radiated by an excited slot at the position of the load, with the radiation strength of the slot related to the loading characteristics in the combined problem. Thus, two parameters determine the scattering behavior of this object: the loading admittance and the position of the slot. Experiments were conducted in the region from 2.8 to 5.2 Gc with a sphere having a 3.1-inch diameter.

6235 Report 5849-1-T, "Theoretical Investigations of Scattering from Plastic Foams," M. A. Plonus, Subcontract from General Dynamics, Sep 63, (32:-), Unclassified.

Note: This report was not obtained.

UNIVERSITY OF MICHIGAN, RADIATION LABORATORY (CONT.)

6236 Report 5849-1-F, "Studies of Scattering by Cellular Plastic Materials," E. F. Knott and T. B. A. Senior, Subcontract from General Dynamics, Apr 64, (80:-), Unclassified.

Note: This report was not obtained.

6237 (Paper), "Radar Reflection Characteristics of the Moon," T. B. A. Senior and K. M. Siegel, Jun 58, (23:13), Unclassified, AD 206 373.

A theory of the scattering processes and surface qualities of the moon is formulated on the basis of experimental observations to explain radar reflection from the lunar surface. A "quasi-smooth" surface scattering mechanism is developed which assumes the echo to comprise the superposition of the reflected pulse from a smooth body, together with contributions from other specular areas that happen to be oriented such as to direct a signal back to earth. The treatment is based on data obtained at wavelengths ranging from 2.5 m to 10 cm. One consequence of the theory is that the initial part of the returned pulse consists entirely of a specular signal arising from a relatively small area near the center of the moon's visible disk. Predictions of permittivity and conductivity also result. It is further shown how the theory can be used as a step toward the design of a lunar communication system.

Note: This is apparently the same as a symposium paper (Abstract 8500J).

6238 AFOSR-64-2423, "On Diffraction by a Half-Plane," A. E. Heins, Grant AF AFOSR-62-341, [submitted 3 Apr 62], (8:3), Unclassified, AD 454 962.

A mathematical analysis of a line source in the presence of a semi-infinite half-plane is presented. The approach brings the problem within the realm of the classical theory of functions of a complex variable and some properties of the Fourier transform theorem.

Note: This document is a reprint of Journal de Mathématiques Pures et Appliquées 43, No. 1, 59-66, (1964).

UNIVERSITY OF NAGOYA, INSTITUTE OF PLASMA PHYSICS (JAPAN)

6239 Report IPPJ-29, "Tables for Microwave Reflection Coefficients from an Inhomogeneous Plasma Column in a Rectangular Waveguide," H. Ikegami and A. Outi, Aug 64, (325:1), Unclassified, AD 455 522.

Reflection coefficients were calculated on an electronic computer, based on an exact solution for waves scattered by a plasma column in a rectangular waveguide, with the electric field of the TE_{10} mode parallel to the column axis (see H. Ikegami, "Scattering of Microwaves from a Plasma Column in Rectangular Waveguides," Report IPPJ-27, April 1964.) Amplitudes and arguments of the reflection coefficients, as well as the voltage standing-wave ratio, are tabulated for several parameters. From the tables can be determined the electron density on the axis of the plasma column and the effective collision frequency of electrons with known plasma radius and waveguide dimension.

UNIVERSITY OF NEW MEXICO, ENGINEERING EXPERIMENT STATION

6240 Technical Report EE-6, "Resolution of Vertical Incidence Radar Return into Random and Specular Components," R. K. Moore, N123(60530)18138A, Jul 57, Unclassified.

Note: This report was not obtained.

6241 Technical Report EE-8, "Reflection and Scattering Coefficients from Several Types of Terrains," A. R. Edison, N123(60530)18138A, Sep 57, Unclassified.

Note: This report was not obtained.

6242 Technical Report EE-9, "Design of an Experiment to Separate Specular and Scattered Radar Returns," R. B. Glascock, N123(60530)18138A, May 58, Unclassified.

Note: This report was not obtained.

6243 Technical Report EE-10, "Comparison of Observed and Calculated Near-Vertical Radar Ground Return Intensities and Fading Spectra," J. A. Cooper, N123(60530)18138A, May 58, Unclassified.

Note: This report was not obtained.

6244 Technical Report EE-15, "Radar Cross Sections of Terrain Near-Vertical Incidence at 415 Mc," A. R. Edison, R. K. Moore, F. J. Janza, et al., N123(60530)18138A, Sep 58 (rev 59), Unclassified, AD 211 249.

(DDC) The reradiation characteristics of several types of terrain were evaluated for near-vertical incidence at 415 Mc. The power return to the radar is separated into specular and scattered components, and coefficients of reflection and of scattering are determined. The coefficients of reflection vary from zero for dense woods with underbrush to near 0.8 for water with other types of terrain falling between these extremes. The scattering coefficients show a dependence upon the angle of incidence and decrease as the angle increases. Densely wooded areas may approach the characteristics of an isotropic area scatterer, while a bare field will give strong scattered return at near-normal incidence and weaker return at angles away from vertical.

6245 Technical Report EE-21, "Radar Cross Sections of Terrain Near Vertical Incidence at 415 Mc, 3800 Mc and Extension of Analysis to X-Band," F. J. Janza, R. K. Moore, and B. D. Warner, N123(60530)18138A, May 59, (54:14), Unclassified, AD 215 543.

Investigations of σ_o and specular scatter ratio K_s are reported for incidence at angles up to 30° from vertical over lakes, deserts, farmland, cities, and forests. Frequencies of 415 Mc and 3800 Mc were used with different pulse-lengths at altitudes from 2000 to 12,000 ft. The radar cross-section of scattered power is obtained by using the Davies model (Abstract 3309J) to fit the control points. Analytical expressions of return power are in terms of the sum of specular and scatter powers; theoretical aspects of return are developed and 27 figures show return data. It is concluded: that asphalt runways and smooth water demonstrated specular surfaces at 415 Mc and under 1500 ft; that scattered power increases with increasing radar height; that reradiating properties of

6245 (Cont.)

residential areas at 3800 Mc are similar to desert return; and that vegetation terrains are close to isotropic reradiation. Scattered power increased at 3800 Mc for desert, farmlands, and cities, whereas specular content decreased.

6246 Technical Report EE-22, "Radar Design Using Acoustical Simulation as a Tool," R. K. Moore, N123(60530)18138A, Apr 59, Unclassified.

Note: This report was not obtained.

6247 Technical Report EE-24 (Summary Report), "Radar Return at Near-Vertical Incidence," A. R. Edison, R. K. Moore, and B. D. Warner, N123(60530) 18138A, Sep 59, (78:121), Unclassified, AD 227 447.

Radar terrain-return data at near-vertical incidence were taken from a C-47 aircraft at altitudes of 200 to 12,000 ft, at frequencies of 415 Mc and 3800 Mc. Target types included water, frozen lake, desert, air field, rangeland, farmland, irrigated farmland, residential area, industrial area, and forest. Above 400 Mc, most terrain forms act as scatterers. Heavily wooded areas appear as nearly isotropic scatterers. For some city targets, σ_o increased, in general, from about 4 to about 18 as frequency increased from 415-3800 Mc. The range of fading varied from 3 dB for smooth water surfaces to 19 dB for non-homogeneous target areas. Path attenuation data are included. In the first section of this report, terrain return is analyzed theoretically by assuming that terrain consists of individual scatterers, and that return consists of specular and scatter components. Parameter choice and experimental procedures are expanded in the second part. A data-reduction procedure is outlined and fading characteristics of returned signals analyzed using statistical methods. About 30 graphs show scattering cross-sections, specular reflection coefficients, and path attenuation characteristics for the various terrains.

6248 Technical Report EE-32, "Glossary of Radar Return Terminology," A. R. Edison and R. K. Moore, N123(60530)18138A, Mar 60, (9:3), Unclassified, AD 239 014.

Informal definitions and/or short discussions are given for 27 terms associated with radar ground return.
Ed: Of limited utility.

6249 Technical Report EE-35, "Radar Terrain Return Statistics at Near-Vertical Incidence," A. R. Edison, N123(60530)18138A, Oct 60, (32:6), Unclassified, AD 250 538.

A statistical analysis of fading characteristics, with emphasis on determining the range of fading (the range of values between which return power can be expected to be found during a given percentage of the time) and the fading rate. Approximate fading rate is determined by the Doppler spectrum of the return signal. The variance spectrum is approximated by either a rectangular or triangular shape. The terrain is assumed to be randomly rough, and the apparent fading frequency is 0.37 f_{max} for a horizontal flight path, and 0.22 f_{max} for a vertical flight path, where f_{max} is the maximum width of the rf power spectrum. The return power spectral density is calculated for both horizontal and vertical flight paths. Assuming ground return with a Rayleigh distribution, fading range is calculated; between the 5% and 95% points on the return power it will generally vary between 12 and 18 dB for a wide-beam antenna.

UNIVERSITY OF NEW MEXICO, ENGINEERING EXPERIMENT STATION (CONT.)

6250 Technical Report EE-37, "Computer Programs for Determining Radar Return Power and Fading Spectra," Chia, Chung, N123(60530)18138A, Oct 60, (76:9), Unclassified, AD 254 080.

A computer program was written for the IBM 704 digital computer to solve the mathematical equations for the mean power returned by terrain to a radar and for its variance spectra. FORTRAN format, input data, flow diagrams, outputs, and checking examples are included. The underlying equations are essentially those derived previously in Technical Report EE-10 (see Abstract 6243). These are rewritten in a form appropriate for numerical analysis. No deductions or conclusions about radar return are made from the computer results.

Note: This report also appeared as the author's M. S. thesis.

6251 Technical Report EE-42, "The Transmitted and Reflected Fields Due to a Plane Wave Incident on a Dielectric Half-Space from a Conducting Half-Space," R. H. Williams, N123(60530)18138A, Feb 61, Unclassified.

Note: This report was not obtained.

6252 Technical Report EE-46, "Radar Terrain Return from the Spherical Earth at Near-Vertical Incidence," B. D. Warner, N123(60530)18138A, May 61, (90:45), Unclassified, AD 260 172.

This report is a radar-return analysis which considers the effect of the earth's sphericity on signals received at high altitudes. It is an extension of earlier work (Abstract 6240), using V. A. Fock's results "Generalization of the Reflection Formulas to the Case of Reflection of an Arbitrary Wave from a Surface of Arbitrary Form," AD 117 276, as applied to a sphere. A scalar theory is presented, and the return signal is resolved into random and specular components; this, in turn, depends upon the assumption of a normal height probability-density function. An approximate scattering cross-section is obtained by the assumption of a normal, bivariate, probability-density function with a Gaussian correlation function. To include the effect of depolarization, lost in a scalar analysis, a constant multiplier of the scatter power integral was used. Development of each phase of the analysis includes many mathematical details. It was concluded that up to 400 miles altitude no significant error is incurred in return power by neglecting the curvature of the earth. A short appendix tabulates typical values of terrain scattering parameters.

Note: This report also appeared as the author's M. S. thesis.

6253 Technical Report EE-53, "High Altitude Radio Altimeter Simulation Study," A. R. Edison, R. K. Moore, and B. D. Warner, N123(60530)18138A, Apr 61, Unclassified.

Note: This report was not obtained.

6254 Technical Report EE-56, "Comparison of Pulse and FM Radar Altimeters Based on Terrain Return Theory," D. L. Quinlan, N123(60530)18138A, May 61, (85:8), Unclassified, AD 260 171.

This report employs the theoretical expressions describing radar terrain return at near-vertical incidence as a basis for comparing pulse and FM radar altimeters. The return is assumed to comprise a specular component plus a scattered component from a random array of scatterers. Emphasis in the report

UNIVERSITY OF NEW MEXICO, ENGINEERING EXPERIMENT STATION (CONT.)

6254 (Cont.)

is on performance of the altimeters being compared, and the treatment of return is drawn essentially from earlier work (see Abstracts 6249 and 8142J).

Note: This report also appeared as the author's M. S. thesis.

6255 Technical Report EE-62, "An Acoustic Simulator for Modeling Backscatter of Electromagnetic Waves," A. R. Edison, N123(60530)18138A, Sep 61, (205:38), Unclassified, AD 265 412.

This report develops the technique of using high-frequency acoustic waves in water to simulate electromagnetic waves in air, and applies it to design problems of radar and altimeter systems. Parameters such as the angular dependence of the mean backscattered power, fading range, and fading rate are duplicated, using appropriate targets and acoustic waves in water. Both distance and time are scaled, which permits geometrical effects to be duplicated. A distribution of excited scattering elements was used as a model of a rough surface to investigate scattering of polarized waves. The resultant field at the receiving antenna was the same for all cases, indicating an essentially scalar model. The frequency range between 200 kc and 5 Mc is best suited for model experiments. A small wooden water tank can be used, with rubberized horsehair lining to reduce echoes.

Flat wooden terrain is modeled by a flat plywood target with dense covering of sand particles of about a wavelength in size; farmland can be represented by using a sparse covering of sand particles. Essential components for an acoustic simulator are the water tank, several submersible piezo-electric tranducers, an oscillator, amplifiers, and pulse circuit. Topics discussed include modeling theory, the acoustic-electromagnetic analogy, radar-system scale factors, pulse and frequency-modulated acoustic simulators, and results of several model experiments.

6256 NOTS TP-2338, "Transactions of the 1959 Symposium on Radar Return. Part I. Unclassified Papers," N123(60530)18138A, 30 Oct 59, (450:-), Unclassified, AD 244 937.

This volume includes the unclassified papers given at a symposium sponsored jointly by the University of New Mexico and the Naval Ordnance Test Station and held at the University on 11-12 May 1959. Classified papers were published separately as NOTS TP-2339 (Confidential) and NOTS TP-2340 (Secret). The broad subject of the symposium was terrain return. Of the 16 papers included in this volume, 14 are pertinent to reflectivity and are individually abstracted below.

6257 Paper in Abstract 6256. "What Radar Can Do For You!," W. E. Burdick, T. B. A. Senior, and K. M. Siegel, (25:3), Unclassified.

Deals with the question of what information about a scattering object can be obtained from study of radar returns. Particular consideration is given to the use of airborne radars to survey the ground; providing sufficient frequency and polarization combinations are available, together with both normal and oblique incidence, a considerable amount of detailed information can be found by radar alone. In the case of objects on the ground, their approximate size and surface characteristics can be discovered, while the presence or absence of multiple reflections indicates the spatial arrangement of the scattering surfaces. If, for example, one object is prominent and relatively isolated, its volume can be deduced from the power scattered at wavelengths large compared with its

6257 (Cont.)

dimensions. On the other hand, with natural ground, an indication of its roughness can be obtained as well as the electromagnetic characteristics (dielectric constant and conductivity) of the soil. In particular, land can be distinguished from water in this way, and yet another application is to investigate stratification in depth in the ground.

6258 Paper in Abstract 6256. "Sea Clutter at High Depression Angles with Applications to the Ground Clutter Problem," M. Katzin (Electromagnetic Research Corp.), (16:0), Unclassified.

A quantitative treatment of sea clutter at large depression angles, based on small facets of the sea surface as the scattering elements. An analytical solution is obtained from which the dependence of σ^o on frequency, wind speed, and angle is deduced. This solution takes into account the slope distribution of the facets, as well as their size distribution. It is found that the frequency dependence at large depression angles is essentially the same as at small angles, up to a high-frequency limit, above which σ^o is substantially constant. At vertical incidence, σ^o is essentially inversely proportional to wind speed, in contrast to an approximate direct proportionality to wind speed at small depression angles. In the neighborhood of vertical incidence, the decrease of σ^o with decreasing depression angle is a modified Gaussian distribution, which depends both on the slope distribution and on the size distribution of the facets. The exponent of the Gaussian term is inversely proportional to wind speed, so that the decay of σ^o from its vertical incidence value is less rapid the higher the wind speed. For depression angles below this decay region, σ^o reaches a plateau, due to scattering by facets which are small relative to the wavelength. Application of the principles to backscattering from terrain is considered.

6259 Paper in Abstract 6256. "Factors Influencing the Enhanced Radar Reflectivity of Thunderstorms," C. P. Mook and J. E. Tompkins (Diamond Ordnance Fuze Laboratories), (11:18), Unclassified.

The intense reflectivity observed in severe convective storms cannot be completely accounted for by the usual integrated radar cross-section of the large raindrops present. Some of the increase in reflection can be accounted for by the melting of frozen precipitation particles, but evidence is accumulating that other factors must be present. This paper discusses the possible role of excessive electrical charges on raindrops in contributing to high reflectivity.

6260 Paper in Abstract 6256. "Airborne Terrain Return Measurements," E. A. Reitz, (Goodyear Aircraft Corp.), (19:0), Unclassified.

Discusses a method of data acquisition and analysis used in studying radar terrain return. An airborne side-looking X-band radar was used to map a strip of terrain, between 10° and 70° depression angle. Airborne data recordings were made on a pulse-by-pulse basis. A precise microwave calibration was made on the film at intervals inflight. These calibrated films were read out in the laboratory on a flying spot scanner and analyzed with analogue computers. Results include:

UNIVERSITY OF NEW MEXICO, ENGINEERING EXPERIMENT STATION (CONT.)

6260 (Cont.)

(1) curves of σ^{o} plotted vs. depression angle and terrain type and (2) standard deviation and probability distribution of σ^{o} for specific terrain type and depression angle.

6261 Paper in Abstract 6256. "Radar Terrain Return: A Theoretical Approach," L. M. Spetner and I. Katz (Applied Physics Laboratory, The Johns Hopkins University), (19:3), Unclassified.

A statistical approach to radar backscattering from terrain is taken in this paper. The normalized radar cross-section σ^{o} is obtained for two different terrain models as a function of λ and of grazing angle θ. The first model is a distribution of isolated independent scatterers such as corner reflectors. For such surfaces, depending on the density of scatterers and their average size, the local dependence of σ^{o} on λ can be as λ^{-2}, λ^{-4}, λ^{0}, or λ^{2}. For such surfaces σ^{o} is dependent of θ.

For a surface where reflection occurs from specular points on the surface and where the distribution of slopes is Gaussian, then the θ-dependence turns out to be of the form $\exp(-k \cot^{2} \theta/2 \sigma_{so}^{2})$, where σ_{so} is the standard deviation of the surface slope distribution. The precise form of σ^{o} depends upon the space spectrum of the slopes. Two cases are worked out, one where such a spectrum is flat out to some cut-off, and the other where the space spectrum has a single peak at a particular wave number. In any case, for small enough λ, σ^{o} varies as λ^{-2}. Comparison of these results with experimental data is necessary in order to determine the parameters of the theory, and indeed, to determine whether the theory is applicable.

6262 Paper in Abstract 6256. "Ground and Sea Return Signal Characteristics of Microwave Pulse Altimeters," J. E. Dye (Emerson Radio and Phonograph Corp.), (32:7), Unclassified.

Mathematical expressions for the return signal in a ground-looking pulse radar or altimeter are derived, using suitable representations for the microwave scattering properties of both ground and sea. These representations are based upon experimentally determined properties of the scattering phenomenon. It is shown that, at high altitudes where the maximum area of the ground (or sea) illuminated is limited by the duration of the transmitted pulse, rather than by the antenna beamwidth, the power return is inversely proportional to the cube of the altitude, and the rise time of the return-pulse leading edge is limited to the duration of the transmitted pulse, even though a rectangular pulse is transmitted. The significance of these properties of the return signal, in terms of the basic design of radar or altimeter equipments, is discussed. Measurements of the return-signal characteristics of the AN/APN-120 pulse altimeter over both land and sea are presented and discussed.

6263 Paper in Abstract 6256. "An Automatic Amplitude Distribution Recorder," I. D. Olin (Naval Research Laboratory), (23:3), Unclassified.

A technique developed for pulse height analysis of nuclear energy releases was adapted to analysis of radar data. The instrument photographs the amplitude

UNIVERSITY OF NEW MEXICO, ENGINEERING EXPERIMENT STATION (CONT.)

6263 (Cont.)

of a group of pulses through a wedge of optical filter glass. The resulting photographs comprise a catalog of distribution density plots, each averaged over the exposure time of the photograph. Improvements in analysis time on the order of 300:1, when compared with a single channel scanning analyzer, have been obtained.

6264 Paper in Abstract 6256. "Radar Altimeter--Ocean Wave Profiler," C. M. Morrow, (Naval Research Laboratory), (29:4), Unclassified.

Airborne and laboratory evaluation of two basic types of high resolution microwave ocean profile recorders is presented. An X-band, FM/CW system showed considerable range distortion as a result of multi-path propagation distortion and phase-front interference. Mathematical analysis confirms that the apparent range of a complex reflecting surface may change with rf phase interference and that such peak errors may cause the indicated location to appear considerably outside any point on the illuminated sea. This is especially true when the frequency deviation is small,and the analysis indicates that wideband techniques should correct this difficulty. Vulnerability to multipath distortion was not observed in a direction-sensitive CW/Doppler system which successfully recorded a true ocean profile. Bidirectional counter techniques are employed to record a profile in increments of $\lambda/2$ with directional sense extracted from the rf phase progression. A counter may thus be used as a velocity memory integrator to extract range data, assuming all radial components normal to the surface are recorded. When the antenna is highly directive, a feature necessary for wave crest-to-trough resolution, vertical stabilization may be required for airborne surveys. Another operational limitation observed is that the profile deteriorated rapidly when the instrument was flown in an airship at a ground speed in excess of 5 knots. These tests indicated that it is necessary to maintain hovering position for a significant number of ocean wave periods in order to obtain an adequate statistical sample useful to the oceanographer.

6265 Paper in Abstract 6256. "Radar Backscatter as a Tool for Siting Communication Terminals," S. R. Bradshaw (Motorola Inc.), M. Acker and C. E. Sharp (Army Signal Res. and Dev. Lab.), (35:1), Unclassified.

Transmission at VHF and higher frequencies is ordinarily limited to terminals within radio line of sight. The usual methods for locating such paths are time-consuming and, in some instances, are not conclusive. A rapid method of locating line-of-sight paths, using the terrain backscatter patterns of a radar PPI scope, is described. Points from which backscatter returns are evident presumably would make satisfactory terminals for a communication circuit to the radar location. Results are discussed and illustrated with composite photographs of area maps and PPI returns. Some of the problems of quantitative path loss predictions based on the PPI returns are discussed, methods of implementing solutions are outlined, and results of a field test and analysis program are given.

6266 Paper in Abstract 6256. "Radar Design Using Acoustical Simulation as a Tool," R. K. Moore (University of New Mexico), (30:1), Unclassified.

Design of short-range radars and altimeters for all ranges may be assisted greatly by the use of acoustic waves in water to simulate electromagnetic waves in air. By use of appropriate scale factors for time, as well as distance and velocity, radar propagation may be scaled into an acoustic tank whose depth is about

UNIVERSITY OF NEW MEXICO, ENGINEERING EXPERIMENT STATION (CONT.)

6266 (Cont.)

that of a swimming pool. Scatter of the acoustic wave from the tank bottom simulates scatter of electromagnetic waves from the ground, and scatter of the acoustic wave from an object in the water simulates that of radar waves from an airborne target. In effect, the acoustic simulator is an analog computer to solve the entire problem of radar return from a scattering target, including the effects of fading and Doppler shift.

6267 Paper in Abstract 6256. "Some Doubts Concerning the Specular-Plus-Scatter Theory of Radar Return," C. S. Williams, Jr. (Sandia Corp.), (10:0), Unc.

This theory predicts that the ratio of the specular component to the scatter component at pulse peak increases with altitude above the terrain, but (for fixed height) decreases as position in the pulse increases. Neither of these tendencies appears in the data taken by Sandia Corp. Another model is described that predicts that the variation with height approaches $1/h^3$ (rather than $1/h^2$ as predicted by the specular-plus-scatter theory) as the altitude h increases, but lies between $1/h^2$ and $1/h^3$ at lower altitudes. It gives results in closer agreement with the Sandia data than the other model.

6268 Paper in Abstract 6256. "Back-Scattering Characteristics of Land and Sea at X-Band," J. P. Campbell (General Precision Laboratory), (30:7), Unc.

A series of experiments is described in which σ^o was measured for selected land areas and water under various surface conditions. The experiments were carried out with an airborne, X-band, pulsed radar. Water surface conditions were observed simultaneously from a boat on the surface. The measurements were made at incidence angles from 0° (normal incidence) to 45°, with vertical, horizontal, and cross polarization. A "fine structure" scale of water surface conditions is introduced and compared with existing scales. Data showing the measured variation of scattering cross-section with incidence angle, polarization, and water surface condition are presented.

Note: This paper also presented at National Conference on Aeronautical Electronics, Dayton, Ohio, May 1958.

6269 Paper in Abstract 6256. "Radar Cross Section of Terrain Near Vertical Incidence at 415 Mc, 3800 Mc, and Extension of Analysis to X-Band," F. J. Janza, R. K. Moore, and B. D. Warner (University of New Mexico), (54:14), Unclassified.

The average radar cross-section per unit area σ^o is determined for scattered power for near-vertical incidence for a 3800 Mc radar over generally encountered terrain types. Areas are selected having homogeneous characteristics and include such terrain types as lakes, deserts, farmland, cities, and forests. These values of σ^o are compared with previously determined values at 415 Mc over the same areas. Mean return pulse characteristics are categorized for both radars and are correlated with σ^o vs. θ, where θ is the angle measured from the vertical. Trends indicated by this analysis are extended to higher frequencies and are compared with published experimental data in the 10 to 50 Gc region. Twenty-eight graphs of results are included; a 9-page appendix examines the time dependence of terrain return to CW and pulsed radars.

UNIVERSITY OF NEW MEXICO, ENGINEERING EXPERIMENT STATION (CONT.)

6270 Paper in Abstract 6256. "Clutter Spectra for an Airborne C-W Doppler Radar," G. Biernson and I. Jacobs (Sylvania Electronic Systems), (62:2), Unclassified.

This paper presents general expressions for the clutter spectra of an airborne CW Doppler radar. The radar is assumed to be carried in a missile, but could also be in a conventional aircraft. In terms of clutter reflection, the ground can be classed into two different types of surfaces, the specular reflecting surface (such as sea or snow) and the diffuse reflecting surface (such as vegetation-covered terrain). Calculations of clutter spectra of a CW Doppler radar for diffuse and spectral reflecting terrain are summarized. These results are obtained from mathematical analyses in two appendices from other sources. Appendix A analyzes clutter return from the main-lobe and from the general side-lobe pattern. Appendix B analyzes clutter from the near side-lobes.

UNIVERSITY OF PUERTO RICO

6271 Final Report (Scientific Report 4; AFCRC-TR-57-202), "Study of Ionospheric Winds. Determination of Ionospheric Drifts and Turbulence from Radio Fading Records," (Report also identified as "Further Observations of Ionospheric Drifts and Related Phenomena with Spaced Radio Receivers"), M. Wiewall, Jr., AF 19(122)-476, Jan 57, (167:14), Unclassified, AD 133 603.

Describes experimental measurements of the drift of ionized matter in the ionosphere; the methods used involve the interference pattern produced at three spaced receivers by echoes from the ionosphere. Echoes were generated by a 2.33-Mc signal illuminating the ionosphere at vertical incidence.

6272 Research Report 1, "Characteristics of a Peculiar Back-Scatter Echo Observed at a Frequency of 21.6 Mc.p.s.," B. Dueño, AF 49(638)-172, [1958 or 59], (24:2), Unclassified, AD 211 178.

Observations of upper-atmosphere echoes taking the form of narrow thin lines extending in all directions. The slant range is typically almost independent of azimuthal bearing; ranges between 1000 and 2000 km were observed. Since the echoes appeared mainly in winter and only sporadically in summer, it is suggested that they arise from the F2 layer.

6273 Research Report 4 (AFOSR-1573), "Fixed Azimuth Sweep Frequency Backscatter Observations from 27 to 54 Mc/s," B. Dueño, AF 49(638)172, 1961, (28:5), Unclassified, AD 266 105.

Description of backscatter observations obtained at 27 to 54 Mc with a continuous-frequency-sweep sounder for a period of seven months. Soundings southward from Puerto Rico were performed with the objective of studying transmissio conditions over the equatorial region, especially during an equinoctial period. It is concluded that long-range trans-equatorial backscatter echoes fall into three categories: (1) simple two-hop propagation supported by high-density concentrations at geographic latitudes 5° north and 35° south; (2) propagation of low-angle rays supported by the decreasing ionization gradient on the far side of the 5° latitude concentration and by the increasing gradient side of the 35° latitude concentration; and (3) frequency-independent propagation caused by fairly large irregularities with high density of ionization embedded in the F2 layer. The instrumentation and the theory of backscattering are also described; the theory assumes a parabolic ionospheric distribution.

UNIVERSITY OF QUEENSLAND (AUSTRALIA)

6274 Scientific Report 6 (AFCRL-62-343), "Observations of Trans-Equatorial Propagation from Brisbane," J. A. Thomas, AF 64(500)-9, Mar 62, (26:22), Unclassified, AD 294 603.

Observations of trans-equatorial backscatter propagation are analyzed with particular reference to anomalous propagation. Seasonal, diurnal, and directional variations are extracted and compared with the behavior of signals propagated via normal modes. Signal strength, fading, and phase-path measurements were made at 16 Mc; preliminary experiments were carried out at 55 Mc and over the range 15-30 Mc using a backscatter ionosonde. Primary data are range-azimuth recordings of pulsed-signal backscatter.

6275 Scientific Report 7 (AFCRL-62-344), "Cross- and Auto-Correlation Effects Associated with Anomalous Transequatorial Propagation at 16 Mc/s," J. A. Thomas, AF 64(500)-9, Mar 62, (19:22), Unclassified, AD 294 604.

Report of autocorrelation and cross-correlation analysis of certain aspects of anomalous trans-equatorial backscatter echoes. Cross-correlations between strength and duration, strength and starting time, and duration and starting time are given, along with the autocorrelation of starting time, duration, and strength. No significant correlation was found between magnetic disturbances and solar variations.

6276 Scientific Report 11 (AFCRL-62-348), "Exospheric Propagation Experiments," J. A. Thomas, B. A. McInnes, and J. Crouchley, AF 64(500)-9, Mar 62, (9:22), Unclassified, AD 294 608.

Experiments were carried out at 16 and 55 Mc to search for possible exospheric propagation of backscatter signals, but none were observed in 6 weeks of continuous recording.

6277 Scientific Report 13 (AFCRL-62-350), "Field-Aligned Ionization Irregularities. An Investigation of Echoes Observed from Brisbane," E. W. Dearden, AF 64(500)-9, Mar 62, (85:42), Unclassified, AD 294 723.

Echoes at 16 Mc from field-aligned ionization irregularities were studied and explanations are proposed for various features of their behavior. The geometry (height, area, ranges, etc.) and spatial movements of the irregularities are described and their relationships to the radiation in the outer Van Allen belt and to other geophysical phenomena such as solar cosmic rays are examined. A mode of propagation involving trapping in horizontal gradients is proposed to account for the observations of echoes from field-aligned irregularities at long ranges by direct transmission in the F-region.

6278 Scientific Report 16 (AFCRL-62-353), "Final Report on Observations of Field-Aligned Irregularities and Transequatorial Propagation," J. A. Thomas, E. W. Dearden, E. M. Matthew, et al., AF 64(500)-9, Mar 62, (17:22), Unclassified, AD 294 698.

Summary of investigations carried out at Brisbane concerning field-aligned irregularities in the ionosphere and trans-equatorial propagation of radio waves. Described are: (1) the extent and movement of field-aligned irregularities; (2) correlation of parameters of field-aligned irregularities with other ionospheric and geophysical phenomena; (3) anomalous trans-equatorial HF signals; and (4) the techniques and sounders used for the investigations. An association is postulated between the E-W elongated irregularities, radiation counts in the outer Van Allen belt, and an F-region anomaly already associated with the observations of red airglow arc.

UNIVERSITY OF SAARBRÜCKEN (GERMANY)

6279 "Some Problems in the Theory of Diffraction and Refraction in Stratified Media," G. Eckart and H. Martin, DA 91-591 EUC-2087, (176:23), Unclassified, AD 404 897.

A number of problems relating to propagation in stratified media are considered; in some cases the stratification is continuous and in others discontinuous. The treatment is highly mathematical and extensive tabulations are included of functions involved in the theory. Creeping waves on cylinders, spheres, and other targets are the topics of several sections.

Ed: The authors' inadequate command of English and the partial illegibility of the handwritten mathematical equations together pose a fairly serious obstacle to the reader who would benefit from this report.

UNIVERSITY OF SASKATCHEWAN (CANADA)

6280 Radio Studies Report RS-5, "A Study of Radio Aurora at UHF. Part IV: Radio Auroral Reflection Mechanisms," F. D. Green, Grant DRB 700121, Feb 59, (45:43), Unclassified, AD 217 962.

Theoretical discussion of various mechanisms that have been proposed to explain radio scattering from aurora. Topics treated include coherent and noncoherent scattering from slight and strong inhomogeneities in electron density, aspect sensitivity, forward scattering, ground reflection, magnetic-ionic effects, and the relation of reflection mechanisms to geomagnetic latitude.

6281 Radio Studies Report RS-9 (Final Report; AFCRL-921), "Meteor Signal Studies," P. A. Forsyth and D. W. Rice, AF 19(604)-7329, 30 Sep 61, (81:17), Unclassifie AD 273 021.

It has been suggested that meteors can be used effectively as probes for investigating various aspects of the disturbed and undisturbed ionosphere. In the present work, combinations of VHF forward-scatter and backscatter circuits were examined in order to assess their utility at measuring the ambipolar diffusion coefficient by means of meteor-signal decay rates. Experimental work indicates that the most useful arrangement is a forward-scatter circuit used in conjunction with a UHF radar. Observations of the decay rates of forward-scattered signals indicate the presence of the same large dispersion that has been reported for backscatter measurements. A qualitative mechanism, based upon an irregularly ionized meteor trail, appears adequate to account for the dispersion. Approximately half the report is given over to a description of equipment.

UNIVERSITY OF SOUTHERN CALIFORNIA

6282 USCEC Report 75-4 (Progress Report 4; RADC-TN-61-139), "Ionized Shock Front Analysis. Part IV: Propagation and Reflection Characteristics of a Uniform Medium with a Nonlinear Electrical Conductivity," M. Epstein, AF 30(602)-2159 31 May 61, (20:6), Unclassified, AD 262 375.

Previous analysis dealing with the effect of nonlinear electrical conductivity on the propagation of a plane electromagnetic wave through a semi-infinite uniform medium is reformulated and extended to include the effects of nonlinear conductivity on the reflecting properties of an interface separating a plasma from free space. Attention is restricted to small degrees of the nonlinearity. Equation solutions indicate the following effects of nonlinear electrical conductivity: (1) the wave number and attenuation factor of the transmitted wave

UNIVERSITY OF SOUTHERN CALIFORNIA (CONT.)

6282 (Cont.)

may be significantly increased; (2) the magnitude of the transmission coefficient may be significantly reduced; and (3) the change in phase across the interface, relative to the result for linear conductivity, may be either positive or negative, depending on whether signal frequency is greater or less than plasma frequency.

6283 USCEC Report 82-203 (Technical Report; AFCRL-62-151), "The Diffraction of Waves by an Elliptical Dielectric Cylinder," C. Yeh, AF 19(604)-6195, Mar 62, (23:7), Unclassified, AD 275 539.

The exact solution is obtained for the problem of diffraction of waves by a dielectric elliptical cylinder or a dielectric strip. Elliptical coordinates are used, and the incident-wave electric vector is assumed either parallel or normal to the cylinder axis. Each expansion coefficient of the scattered or transmitted wave is coupled to all coefficients of the series expansion for the incident wave, which is not the case for a circular dielectric cylinder or for a perfectly conducting elliptical cylinder. No numerical analyses of the solution are included in the report.

6284 USCEC Report 82-209; EE-19 (Technical Report; AFCRL-63-47), "An Application of Sommerfeld's Compex Order Wave Functions to the Problem of Radiation from a Dielectric Coated Cone," C. W. H. Yeh, AF 19(604)-6195, Mar 63, (13:8), Unclassified, AD 404 168.

Sommerfeld's complex-order wave function and its orthogonality properties are used to obtain the exact solution for the electromagnetic field excited by a slot on a dielectric-coated, spherically tipped cone. Results are valid for both near and far zones, and can be used to calculate the electromagnetic field radiated from a spherically tipped cone having a dielectric sheath or cold plasma sheath. The technique is applicable to other similar problems, including specifically the diffraction of waves by a dielectric-coated spherically tipped cone. It should be noted that the required complex-order wave functions have not been tabulated, and only certain limiting values are known; their tabulation would be a task suited for a computer.

6285 USCEC Report 82-216; EE-36 (AFCRL-64-260), "Perturbation Approach to the Diffraction of Electromagnetic Waves by Arbitrarily Shaped Dielectric Obstacles," C. W. H. Yeh, AF 19(604)-6195, Mar 64, (26:13), Unclassified, AD 601 002.

A perturbation method is developed to treat diffraction of electromagnetic waves by an arbitrarily shaped dielectric obstacle whose boundary may be expressed in the general form, in spherical coordinates:

$$r_p = r_o(1 + \delta f_1(\theta, \Phi) + \delta^2 f_2(\theta, \Phi) + \ldots)$$

where r_o is the radius of an unperturbed sphere and $f_n(\theta, \Phi)$ are arbitrary, single-valued, and analytic functions; δ is chosen such that

$$\sum_{n=1}^{\infty} |\delta^n f_n(\theta, \Phi)| < 1, \quad 0 \leqq \theta \leqq \pi, \quad 0 \leqq \Phi \leqq 2\pi .$$

UNIVERSITY OF SOUTHERN CALIFORNIA (CONT.)

6285 (Cont.)

Detailed analysis is carried out to the first order in δ, and procedures to obtain higher-order terms are indicated. The perturbation solutions are valid for both near- and far-zone regions, and for all frequencies. An example is given of the scattering of plane waves by a dielectric spheroid.

6286 USCEC Report 82-218; EE-38 (AFCRL-64-480), "Interaction of Microwaves with an Inhomogeneous and Anisotropic Plasma Column," C. Yeh and W. V. T. Rusch, AF 19(604)-6195, May 64, (25:8), Unclassified, AD 606 976.

Analytical treatment of the interaction of microwaves with a cold, radially inhomogeneous plasma column confined by an impressed axial static magnetic field. Extensive numerical results for backscatter cross-sections are presented for various interesting ranges of the parameters involved. It is found that the often-used homogeneous model for interpreting experimental data can sometimes lead to ambiguous results because of the interdependence of the average plasma frequency, the gyro-frequency, and the inhomogeneity of the plasma density distribution.

6287 USCEC Report 82-219 (Final Report; AFCRL-65-7), "Wind Tunnel Investigation of the Interaction of Radio Waves with Shock-Ionized Flow Fields," Z. A. Kaprielian, AF 19(604)-6195, Dec 64, (194:105), Unclassified, AD 457 512.

This report summarizes work done during a four-year period under the subject contract; both experimental and theoretical studies are described. The work comprised a number of more-or-less independent study topics, each of which is described in enough detail as to give useful information on the subject. More complete details are available in the technical reports issued under the contract, and have in many cases been published elsewhere also. The experimental studies are grouped under two broad headings: wind-tunnel investigation of the interaction of radio waves with shock-ionized flow fields, and steady-state hot plasma facilities for guided wave propagation studies. The theoretical studies are classifiable under the headings of: interaction of electromagnetic waves with plasmas, and classical electromagnetic problems. Topics falling under the first heading include: surface waves on a plasma-clad cylinder, and interaction of microwaves with an inhomogeneous and anisotropic plasma column. The latter heading includes the following topics pertinent to reflectivity: (1) diffraction of waves by an elliptical dielectric cylinder; (2) scattering of obliquely incident light waves by elliptical fibers; (3) dyadic Green's function for a radially inhomogeneous spherical medium; (4) diffraction of scalar waves by penetrable disks; and (5) perturbation approach to diffraction of electromagnetic waves by arbitrarily shaped dielectric obstacles.

6288 USCEE Report 102 (SSD-TDR-63-408), "A Model for the Power Spectrum of Returned Echoes from a Random Collection of Moving Scatterers," D. G. Childers and I. S. Reed, AF 04(695)-304, Dec 63, (18:4), Unclassified, AD 429 475.

A theoretical model is developed for the power spectrum of backscattered noise (random clutter) that is correlated with the radar signal. The clutter cloud is assumed to be a collection of individual point scatterers moving about, each reflecting signals independently of the others. Individual motions of the scatterers are assumed to be independent of one another, but the cloud as a whole

UNIVERSITY OF SOUTHERN CALIFORNIA (CONT.)

6288 (Cont.)

is taken to have an overall drift velocity. The distribution of the echo arrivals is assumed to constitute a nonstationary Poisson process; the nonstationary expected value and covariance function for the clutter-noise process is determined. Finally, the process is approximated as stationary and the power spectrum is determined.

6289 USCEE Report 118 (SSD-TR-64-199), "Mathematical Properties of Polarization and Scattering Matrices," L. K. Montgomery, Jr., AF 04(695)-537, Nov 64, (37:8), Unclassified, AD 453 089.

This is a very clearly written, mathematically oriented report aimed primarily at providing a more rigorous base and appropriate corrections to previous work (Abstract 5520 and "Radar Polarization Power Scattering Matrix," C. D. Graves, Proc. IRE, 44, 248-52 (1956).) The relation is developed between the different sets of two orthogonal polarizations of an electromagnetic wave and the different sets of basis vectors in a 2-dimensional complex space. Transformation from one polarization basis to another is easily accomplished. It is shown that if a target has periodic motion (other than rotation about an axis of revolution), its scattering matrix is periodic in time and can be expanded in a matrix Fourier series. The radar return signal, when decomposed into circularly polarized components, is separated into two frequencies which are the sum and difference of the transmitted frequency and the target-rotation frequency.

UNIVERSITY OF TEXAS, DEFENSE RESEARCH LABORATORY

6290 Part I of Appendix D to Final Report, "Unclassified Technical Memoranda Issued Under The Contract, Part I," AF 33(616)-2290, 31 Aug 57, (74:7), Unclassified, AD 141 248.

Contains five technical memoranda, of which only the following is pertinent to reflectivity.

"Dependence of Radar Return from Chaff on the Distribution of Dipoles into Vertically and Horizontally Oriented Groups (DRL Technical Memorandum 14)," B. M. Brown, 1 June 1955, (18:2).

The angular dependence of the radar return from a cloud of linear $\lambda/2$ dipoles was estimated for a distribution of N dipoles, with n horizontally oriented and N-n vertically oriented, as a function of the elevation angle of the cloud. The method of Van Vleck, Bloch, and Hamermesh (J. Appl. Phys. 18, 274 (1947)) was used to obtain the backscattered fields. A final result was a table showing power return as a function of cloud elevation, fraction of horizontal dipoles in the cloud, and mode of polarization.

6291 Part II of Appendix D to Final Report, "Unclassified Technical Memoranda Issued Under The Contract, Part II," AF 33(616)-2290, 31 Aug 57, (105:10), Unclassified, AD 141 249.

Of five technical memoranda contained in this volume, two pertain to chaff reflectivity.

"Concerning Wide-Band Radar Reflectors (DRL AF Technical Memorandum 47)," S. Armentrout, (38:7).

UNIVERSITY OF TEXAS, DEFENSE RESEARCH LABORATORY (CONT.)

6291 (Cont.)

Chaff, thin disks, and spherical shells are compared in terms of the weight of reflecting material required to produce a given cross-section over a specified band. Basic assumptions were: (1) the radius, a, of the disks and shells is large relative to λ; (2) disk and chaff are thin ($\ll \lambda$); and (3) the material is perfectly conducting. In all cases, chaff exhibits greater than a 3:1 advantage over disks over the entire frequency range, while disks are twice as efficient as spheres.

"Radar Return from Tuned Dipoles for Orientations Other than Vertical and Horizontal (DRL AF Technical Memorandum 34)," B. M. Brown and R. Beeler, 5 Apr 57, (14:0).

This is an extension of Tech Memo 14 (Previous abstract) to cover the case of dipoles oriented at angles other than vertically and horizontally. As before, the dipole current distribution is assumed to be cosinusoidal. Averaged returns are computed for horizontal transmission and reception and for vertical transmission and reception.

6292 Appendix B to Final Report (ASD-TN-61-37), "Cross Sections and Polarization Ratios of Dipole Clouds (DRL AF Technical Memorandum 53)," B. M. Brown, AF 33(616)-5164, 1 Sep 60, (235:4), Unclassified, AD 257 624.

Describes programs for computing responses from horizontal and vertical dipoles, and for computing the ratio of vertical and horizontal responses from a cloud containing both vertical and horizontal dipoles. DRL AF Technical Memoranda 43 and 47 derive the equations used. New expressions were developed for $\sigma_{vv}(\Phi)/\lambda^2$ (normalized response of vertical dipoles to vertical polarization) and $\sigma_{hh}(\Phi)/\lambda^2$ (normalized response of horizontal dipoles to horizontal polarization), where Φ is the angle between dipole and vertical. Plots are shown of the cross-section per dipole for A values of 20, 100, 200, 500, and 2000; ℓ/λ values between 0.150 and 1.100; and elevation angles between 0° and 90° for all possible combinations of polarization and dipole orientation. Here A is length-to-width ratio, and ℓ/λ is length-to-wavelength ratio.

An expression for σ_{vv}/σ_{hh} is derived as a function of the ratio of the number of vertical dipoles to the number of horizontal. Ratios of 0, 0.1, 0.2, 0.3 ... 0.9 are used. Plots of σ_{vv}/σ_{hh} as a function of R, ℓ/λ (from 0.180 to 0.980), A (from 20 to 2000), and elevation angle θ (from 0° to 90°) are given. Here R is the ratio of the number of vertical dipoles to the number of horizontal dipoles.

Comparisons are made between σ_{hh} and σ_{vv} measured and predicted by DRL methods and by the Van Vleck method. The latter assumes an orientation distribution uniform in angular space, where the DRL method assumes that the cloud consists entirely of a mixture of vertical and horizontal dipoles. Measurements at S-band showed that the DRL prediction gave values 3 to 4 dB too large for all dipoles near the tuned length, but the Van Vleck method involved errors ranging over ±6 dB; it is concluded that the DRL cloud model is superior to that of Van Vleck.

6292 (Cont.)

Extensive tables relate ℓ/λ, A, θ, and R to $\sigma_{vv}(0)/\lambda^2$ and $\sigma_{hh}(90)/\lambda^2$.

Note: This thick volume contains 9 pages of text, plus over 225 pages of graphs and computer print-outs.

6293 Appendix C to Final Report (ASD-TN-61-37), "A Power-Spectrum Program for the IBM 650 Computer (DRL AF Technical Memorandum 54)," S. E. Smith, AF 33(616)-5164, 15 Oct 60, Unclassified, AD 257 627.

(DDC) The power-spectrum program described in the report uses for its input the autocorrelation function, as calculated by the program described in DRL AF Technical Memorandum No. 51. The spectrum program prepares a table of the cosines which will be needed and then generates appropriate look-up instructions for the cosines during the computation. This is considerably faster than recomputing each cosine as needed. The output of the spectrum program gives the frequency interval, the raw spectrum, the Hammed and Hanned spectra, and the cumulative or integrated versions of these three spectra.

6294 Appendix G to Final Report (ASD-TN-61-37), "The Dispensing and Behavior of Chaff in Space (DRL AF Technical Memorandum 58)," J. H. Henson and J. W. Craig, AF 33(616)-5164, 12 Apr 61, (44:0), Unclassified, AD 257 626.

The report is concerned solely with techniques for properly dispersing chaff in space, and contains no data on reflection characteristics as such. It is concluded that chaff dipoles can be dispersed in space by the vapor pressure of fluid in which they are immersed in the package. It is also determined that chaff dispersed omnidirectionally from an orbital vehicle will form a belt around the earth, whereas when given a uniform dispensing velocity perpendicular to the original circular orbital velocity will grow and change in a cyclic manner but not form a belt.

6295 Appendix H to Final Report (ASD-TN-61-37), "Dipole Cross Sections Calculated by Variational Techniques (DRL AF Technical Memorandum 59)," B. M. Brown, AF 33(616)-5164, 5 Apr 61, (105:4), Unclassified, AD 257 625.

This document is very similar to Tech Memo 53 (Abstract 6292) except that the method of Tai was used to compute dipole cross-sections, aided by the Van Vleck and DRL methods discussed in Memo 53. Extensive tables show cross-section as a function of length-to-radius ratios, R, ℓ/λ, θ, and A. Expressions and methods show how to obtain σ_{hh} and σ_{vv} when mixtures of horizontal and vertical dipoles are used and the fraction of vertical dipoles are known.

Laboratory tests were performed on operational chaff to obtain σ_{vv}/σ_{hh}, which was used with the computed tables to estimate the fraction of vertical dipoles. The absolute cross-sections σ_{vv} and σ_{hh} were then computed and measurements taken. Predicted and actual cross-sections agreed within 1.5 dB in the range $0.19 \leqq \ell/\lambda \leqq 0.37$, but at $\ell/\lambda = 0.5$ a difference of -4.0 dB was observed, which was attributed to shielding and coupling effects. Predicted values based on random orientation completely failed to give correct polarization response ratio at all values of ℓ/λ and θ for which measurements were taken. It is concluded that the DRL vertical-horizontal dipole distribution should be used for dipoles

UNIVERSITY OF TEXAS, DEFENSE RESEARCH LABORATORY (CONT.)

6295 (Cont.)

less than 3 inches long falling in non-turbulent air. As length increases, the distribution shifts toward the random-orientation model.

Note: This thick document comprises 4 pages of text, plus over 100 pages of tabulations reproduced from a computer print-out.

6296 Ph.D. Thesis, "A Lunar Echo Study at 425 Mcs," R. C. Mathis, Jun 63, (81:17), Unclassified, AD 415 812.

Some results and accompanying analysis are given about the moon's surface, as determined at 425 Mc using a 120-kw radar located in Trinidad. Most energy was observed to be reflected from a central region of the lunar disk having a radius of about 0.31 of the total radius. Return from both front and rear portions of the visible lunar hemisphere was observed to be essentially specular. A check on the hypothesis of a covering dust layer on the moon could not be made, although such an hypothesis would explain observed differences in polarization.

UNIVERSITY OF TEXAS, ELECTRICAL ENGINEERING RESEARCH LABORATORY

6297 Report 94, "A Survey of the Characteristics and Potential Uses of Millimeter Wavelength Radio Waves," A. W. Straiton, Nonr-375(07), 31 Aug 57, (19:0), Unclassified, AD 147 823.

Summarizes the radio propagation characteristics of millimeter waves and discusses several applications such as short-range secure communications, air-to-air or air-to-ground communications, and precision short-range navigational aids. Briefly discussed are the reflection characteristics of an 8.6-mm signal propagated across a lake with and without wind and over a fairly smooth field. Scattering by rain and fog droplets is also mentioned.

6298 Report 98, "Some Problems in Modeling Water Waves Relating to the Back-Scattering of Microwave Radio Energy," R. C. Staley, Nonr-375(01), 21 Feb 58, (6:15), Unclassified, AD 154 630.

A brief discussion on the possibility that backscattering of radio energy from the sea surface at centimeter wavelengths can be modeled by the back-scattering of millimeter wavelengths from small laboratory water waves. The status of knowledge concerning the dependence of average cross-section per unit area (σ°) on sea and radar parameters is briefly summarized, based chiefly on Kerr (D. E. Kerr, Vol. 13 of the MIT Radiation Laboratory Series) and Pierson ("Wind Generated Gravity Waves," W. J. Pierson, Jr., Adv. in Geophysics 2, 93-178 (1955). The assumption is made that capillary waves will dominate back-scattering at millimeter wavelengths, and a qualitative argument leads to the conclusion that σ° for millimeter wavelengths and capillary water waves will be proportional to the 9/2 power of wind velocity, rather than the 5/2 power which applies for centimeter wavelenghts and gravity water waves according to Kerr.

Since the early theory of Kerr (which leads to a λ^{-1} dependence for σ°) is presently under some suspicion, his conclusion should not be accepted uncritically

6299 Report 124, "Final Report on Research Activities in Millimeter Radiowaves and Geomagnetics," Nonr-375(01), 31 Jul 61, (32:0), Unclassified, AD 262 514

UNIVERSITY OF TEXAS, ELECTRICAL ENGINEERING RESEARCH LABORATORY (CONT.)

6299 (Cont.)

This final report briefly surveys the activities and accomplishments of a 10-year basic research program which studied the propagation of millimeter-wavelength radiation. It provides appropriate references to detailed technical reports, including a comprehensive listing of the reports, publications, theses, and dissertations prepared under the program.

6300 "Research on Microwave Properties of Materials for Airborne ECM Application," AF 33(616)-5581, Unclassified.

Quarterly Engineering Report	Date	Pages:Refs.	AD No.
2	30 Sep 58	23:0	206 225
4 (First Annual)	31 Mar 59	12:0	215 556
5	30 Jun 59	8:1	220 432

These reports briefly discuss studies of absorber reflection, of attenuation losses in ionized gases subject to a magnetic field, and of the dielectric constant for organic materials. Only the reports listed above were received.

In Report 2, two methods are described for measuring X-band absorption. The first is essentially the substitution method, in which the difference in attenuation readings with and without the sample represents the absorption loss. The other method was a tunable bridge circuit. Measurements were made on three groups of gases: CH_3Cl, CH_3Br, and CHF_3; $CHCl_2F$, $CHClF_2$; and CH_2F_2, CBr_2F_2, CCl_2F_2. Absorption data for the first group is well known, for the second was reported, and for the third was unknown. Measurements of CBr_2F_2 and CCl_2F_2 showed no measurable loss at 9400 Mc ($\tan \delta < 0.5 \times 10^{-4}$). For CH_2F_2, $\tan \delta = 1.3 \times 10^{-4}$ at 1 atmosphere pressure.

Report 4 is little more than a progress summary.

In Report 5, concerning attenuation losses in ionized gases, three figures show the relationships between ionization current, pressure, and frequency shift when the evacuated cavity has a resonance of 8992 Mc. Resonance varies from 9025 to 9150 Mc with helium.

6301 Report 5-51; Final Report, AF 33(616)-6257, 30 Sep 61, (10:0), Unclassified, AD 267 863.

Brief summaries are given of research areas covered more thoroughly in other reports under the contract. The only area pertinent to reflectivity was an experimental program involving bistatic reception of 3-Gc signals reflected from the moon and originating from a transmitter at the Royal Radar Establishment, Malvern, England. Amplitude spectra were obtained. No data are given in this document. Details of that work are in EERL Technical Report 5-38, "Bistatic Moon-Reflection Measurements Between Malvern, England, and Austin, Texas at 3 kMcs," A. W. Straiton and C. W. Tolbert (not obtained for abstracting).

6302 Report 5-52, "Attenuation and Emission of 58 to 62 kMc/s Frequencies in the Earth's Atmosphere," AF 33(657)-7333, ARPA Order 216-61, 31 Mar 63, (152:58), Unclassified, AD 400 954.

UNIVERSITY OF TEXAS, ELECTRICAL ENGINEERING RESEARCH LABORATORY (CONT.)

6302 (Cont.)

Techniques and results of investigation into the emitting and absorbing characteristics of the earth's atmosphere at frequencies associated with the 60-Gc complex of oxygen lines. No reflectivity data are included.

6303 Report 6-36 (ERD-TN-60-766), "Some Effects of Trees on Low Angle Radio Propagation at a Wavelength of 10.4 Cm," A. H. LaGrone and C. W. Chapman, AF 19(604)-5504, 15 Jul 60, (29:4), Unclassified, AD 240 879.

Results of measurements at 2.8 Gc over wooded areas, the elevation angle to the transmitter being the primary variable. Using vertical polarization, the effects of single trees and clusters of trees on the apparent location of the signal source were measured. Data are presented which assist in the evaluation of sites for low-angle radar trackers. No reflectivity data are given.

6304 Scientific Report 6-56 (AFCRL-63-921), "Observations At and Near Vertical Incidence with an M-33 Radar," A. P. Deam, G. B. Walker, and A. H. LaGrone, AF 19(604)-8038, 30 Nov 63, (40:11), Unclassified, AD 429 529.

Results of limited observations of angels obtained with an M-33 X-band radar in a fixed vertical position. Existing theories are used to derive back-scatter cross-sections for various atmospheric phenomena, insects, and birds, in order to place limits on the signals to be expected from various sources. Dot-like angels and large birds were tracked. Occasionally seen line-like returns might be attributed to extended refractive-index layers, cloud-air interfaces, or perhaps automobile reflections returned via side lobes. It is suggested that some of the dot-like returns were from insects or birds, since the density of such echoes decreased sharply with altitude and most of them had a velocity component relative to the wind. Characteristics of 13 tracked targets are listed. It is suggested that orthogonal polarizations and two wavelengths be employed to differentiate between atmospheric inhomogeneities, insects, and birds.

UNIVERSITY OF TORONTO (CANADA)

6305 Research Report 12, "Scattering from a Circular Loop," V. H. Weston, Grant DRB 5540-02, Aug 57, (16:2), Unclassified, AD 146 304.

In this short mathematical treatise, expressions for the scattered field and echo area are derived for a perfectly conducting toroid, using toroidal wave functions. Previous analysis of Kouyoumjian (Abstract 7092J) was valid only for thin wires. A plane wave is assumed incident and the scattered field is determined for any polarization and angle of incidence, with error on the order of $(r/a)^2$, where r = wire radius and a = loop radius. Echo area for four angles of incidence is calculated for the cases of polarization in the plane of the ring and in the plane of incidence.

6306 Research Report 18, "Diffraction of a Plane Wave by an Infinite Plane Grating," Z. Szekely, Grant DRB 5540-02, Jan 59, (30:8), Unclassified, AD 228 949.

Study of the diffraction and transmission properties of an infinite plane grating consisting of infinitely long, infinitesimally thin, perfectly conducting parallel ribbons of equal width, with the spacing between adjacent ribbons equal tc

UNIVERSITY OF TORONTO (CANADA) (CONT.)

6306 (Cont.)

their width. Theoretically exact expressions were derived for the scattered fields for $ka \cos \theta = n\pi$, where k is the wave number, a is the width of the ribbons, θ the angle between the direction of incidence of the wave and the vector lying perpendicular to the edges of the ribbons in the plane of the grating, and n an integer. The method of solution involved a technique for solving infinite sets of simultaneous equations with the aid of appropriate contour integrals.

UNIVERSITY OF WASHINGTON

6307 Technical Report 47 (AFCRL-100), "The Variational Method for Evaluation of Scattering of Electromagnetic Waves by Obstacles. II. Scattering by a Periodically Apertured Conducting Screen," R. B. Kieburtz, A. Kishimaru, and G. Held, AF 19(604)-4098, Jan 61, (40:10), Unclassified, AD 251 832.

Scattering by a plane conducting screen containing a periodic array of square apertures is calculated by the variational method. Results are given as a function of wave number and aperture size for normally incident plane waves. The appropriate trial function is discussed and the choice justified. Results are interpreted in physical observables such as a resonance behavior where the screen is completely transmissive. A square resonance aperture in a square TE_{11} excited waveguide is also treated. The calculations show good agreement with experiment. Applications to antenna problems are also discussed.

6308 Technical Note 1, "Preliminary Results of a Study of Pacific Storm Systems Using 1.87 cm Radar," C. W. Kreitzberg, AF 19(604)-5192, May 61, (44:3), Unclassified, AD 258 600.

An attempt was made to determine the relationships between synoptic-scale weather features and echoes observed by a vertically-directed 1.87-cm APQ-39 radar. Synoptic data are compared with radar echoes photographically recorded from a time-height trace and classified into echo types by means of criteria developed in this study. Important discrepancies between classical occlusion models and radar observations are pointed out, and a simple occlusion theory suggested by the observations is presented.

6309 Technical Report 7 (AFCRL-62-469), "Detailed Analyses of Selected Pacific Storms Based on Continuous Radar Records and Short-Interval Serial Ascents, Volume V. Case of June 5-7, 1961," R. J. Reed, AF 19(604)-5192, Jul 62, (55:-), Unclassified, AD 290 242.

An investigation of wind and frontal structures and the seemingly erratic changes in echo character based on observations from a 1.87-cm APQ-39 vertical-beam radar, radiosonde records, and pilot reports. Most of this report comprises weather charts, graphs and tables of sounding data, and continuous film-strip A-scope photographs. From an analysis of the echo patterns and synoptic data, explanations are offered for the wind and frontal structures and changes in echo character.

6310 Final Report (AFCRL-63-222), "Application of Radar Data to Problems in Synoptic Meteorology," R. J. Reed and C. W. Kreitzberg, AF 19(604)-5192, Dec 62, (82:7), Unclassified, AD 298 616.

UNIVERSITY OF WASHINGTON (CONT.)

6310 (Cont.)

Major emphasis is on synoptic meteorology and the application of radar data from a 1.87-cm APQ-39 vertical-beam radar to synoptic problems. Case studies of squall-line formations and serial ascents are presented. Three bases for echo-classification systems are considered: corresponding precipitation processes, echo appearance and extent, and analysis of digitalized data. Also investigated is the relation of radar echoes to precipitation, cloud visibility, turbulence, and icing reported by aircraft. It is suggested that sporadic echoes observed in stable cloud masses are indicative of fluctuations between water and ice. Turbulence was found to be associated with unstable echoes; the most severe and extensive example occurred near a sharp fast-moving occlusion. Icing was observed in both the presence and the absence of echoes. From this study it appears that echo patterns of a 1.87-cm radar are not sensitive or precise indicators of meteorological parameters.

UNIVERSITY OF WISCONSIN, MATHEMATICS RESEARCH CENTER

6311 Technical Summary Report 15, "On the Diffraction and Reflection of Waves and Pulses by Wedges and Corners," F. Oberhettinger, DA 11-022 ORD-2059, 5 Dec 57, (48:44), Unclassified, AD 156 733.

A highly mathematical theory using a transform representation is developed for the problem of diffraction by a wedge. The case of excitation of a perfectly reflecting wedge by a line source parallel to the edge of the wedge is considered. An asymptotic expansion is employed to obtain the far field excited by the incidence of a plane wave on a wedge. Properties of this field are discussed and compared with those of the corresponding half-plane field; expressions are derived for the energy radiated by a Hertz dipole in the presence of either the wedge or a corner reflector. The relation of the theory to geometric optics is treated, as are pulse and transient solutions to the problems mentioned.

6312 Technical Summary Report 124, "Turning Point Problems in Diffraction Theory," N. D. Kazarinoff, DA 11-022 ORD-2059, Dec 59, (10:12), Unclassified, AD 231 353.

A short mathematical discussion of certain turning-point problems in the theory of ordinary differential equations that are related to scattering. The treatment is confined to the scalar problem:

$$\nabla^2 u - u_{tt} = \delta(x) e^{i\omega t} ,$$

$$u(x,0) = f(x),\ u_t(x,0) = g(x),$$

where $\delta(x)$ is the source distribution and u satisfies a homogeneous boundary condition.

Note: This report is based on a paper presented at the Symposium on Ordinary Differential Equations, Mexico City, September 1959.

UNIVERSITY OF WISCONSIN, MATHEMATICS RESEARCH CENTER (CONT.)

6313 Technical Summary Report 256, "Mathematical Foundations of Diffraction Theory," Calvin H. Wilcox, DA 11-022 ORD-2059, Aug 61, (97:10), Unclassified, AD 263 230.

(BD-2167) The purpose of this paper is to provide the foundation for a mathematical theory to determine the diffracted electromagnetic wave produced when a prescribed wave, propagating in a homogeneous isotropic dielectric medium, strikes a prescribed metallic obstacle. A precise mathematical formulation together with theorems guaranteeing the existence and uniqueness of the solution and theorems describing the functional properties for this problem are discussed.

6314 Technical Summary Report 316, "Multiple Scattering of Plane Waves by Two Elliptic Cylinders," N. Zitron, DA 11-022 ORD-2059, May 62, (31:21), Unclassified, AD 278 745.

(BD-4194) An asymptotic solution is obtained for diffraction of a plane wave by two parallel, infinite, widely spaced elliptic cylinders. The solution is a special case of a previous result for cylinders of arbitrary shape. Elliptic cylinders are of special interest because diffraction by an elliptic cylinder is the most general separable, two-dimensional exterior boundary problem for the wave equation, and because a convex cylinder can be approximated by an elliptic cylinder. The far field is given in terms of the Mathieu function solutions obtained for diffraction of a plane wave by a single elliptic cylinder and in terms of the spacing d up to terms of order $d^{-3/2}$. The case of collinear major and minor axes are considered. Scattering cross sections are calculated in both cases. Results show how the Mathieu function solutions for the individual cylinders are modified when they are combined and, consequently, combinations of elliptic cylinders have filtering properties which depend on the orientations of the cylinders.

6315 Technical Summary Report 365, "A Numerical Investigation of Scattering of Radiation of an Asymmetric Source by a Circular Cylinder," N. Zitron and J. Davis, DA 11-022 ORD-2059, Mar 63, (33:16), Unclassified, AD 401 544.

An asymptotic expansion is employed to explore the limits of validity of plane-wave and line-source assumptions for the incident wave, in the problem of scattering of waves by an infinite cylinder. Detailed numerical calculations are made in the cases where the source is a plane wave, a line source, and a slotted cylinder. Curves are presented showing variation of the amplitude of the scattered wave with respect to spacing of source and scatterer. The effect of the directivity of a source is discussed.

6316 Technical Summary Report 440, "The Use of Singular Integrals in Wave Diffraction Problems with the Solution of the Problem of Scattering by a Dielectric Wedge," M. Papadopoulos, DA 11-022 ORD-2059, Nov 63, (73:11), Unclassified, AD 430 767.

The problem of diffraction by an infinite lossless dielectric wedge is solved for all wedge angles. A plane wave of delta-function profile is incident normally on the vertex. The diffracted field is homogeneous and may be represented as part of certain integrals of Cauchy type. The situation examined is the general one of two infinite wedges with one surface and vertex in common and with the second surface of each wedge supporting definite homogeneous boundary conditions

UNIVERSITY OF WISCONSIN, MATHEMATICS RESEARCH CENTER (CONT.)

6316 (Cont.)

involving first derivatives. Solution involves satisfying conditions at the interface, at the vertex, and at the diffracted wave fronts, leaving boundary conditions at the second wall of each wedge to be satisfied simultaneously by a pair of nonsingular Fredholm equations; the plane wave result is used as the base of further solutions. The two-dimensional case of a line source depends on the solution for a plane wave at normal incidence; the three-dimensional scalar case of a point source depends on the solution for a plane wave at skew incidence. The corresponding vector problem is reduced to a pair of modified scalar problems. Solution is described for a plane electromagnetic wave at skew incidence, and this leaves the point source field to be set up just as in the scalar case. An analytic continuation is possible to cover the change from a hyperbolic to an elliptic situation. This is the basis of a description of the diffraction of a totally reflected plane wave.

WASHINGTON STATE UNIVERSITY

6317 M. S. Thesis, "Investigation of North (Field Aligned) Echoes," C. L. Allison, 64, (49:31), Unclassified, AD 442 386.

HF backscatter soundings of F-layer field-aligned echoes were recorded to define characteristics such as aspect sensitivity, absorption, electron density, diurnal and seasonal variations, and variations with solar cycle. Data were obtained from the PPI display of HF pulsed radars operating at 12, 18 and 30 Mc.

WEATHER BUREAU, DEPARTMENT OF COMMERCE

6318 Final Report, "National Severe Storms Project. Severe Storm Detection and Circumnavigation," J. T. Lee, D. A. Kohl, J. E. Miller, et al., ARDS-A-176, Jun 63, (440:78), Unclassified, AD 433 552 or 432 066.

This report comprises several independent studies concerning specific areas of interest in an investigation of severe storms and their effect on air traffic. Those studies which contain some radar-reflectivity information are as follows. The individual studies were done originally by various organizations under different contracts and are reprinted here; most have appeared previously as separate reports.

"Thunderstorm Turbulence Measurements by Aircraft and Concurrent Radar Echo Evaluations," J. T. Lee (56:12).

Data from controlled aircraft penetrations of thunderstorms and from radar observations with a 10-cm WSR-57 radar were used to investigate the relationship between thunderstorm growth, radar measurements, and turbulence. There appears to be no direct correlation between turbulence and either radar-echo intensity or gradient of successive reflectivity values. Rather, a positive correlation is indicated between turbulence and rate of change in radar-reflectivity value, particularly from values above 10^3 mm^6/m^3 when derived gust velocities can exceed 20 ft/sec. The most likely position of severe turbulence in the thunderstorm complex is also discussed.

WEATHER BUREAU, DEPARTMENT OF COMMERCE (CONT.)

6318 (Cont.)

"500-Kc/Sec. Sferics Studies in Severe Storms," D. A. Kohl and J. E. Miller (36:7).

The count rate of 500-kc sferics, monitored with special sferics equipment, is related to severe weather events observed with a 10-cm WSR-57 radar. Although less than half of the radar echoes were found to produce sferics activity, 98% of the observed 500-kc sferic activity originated in cloud regions producing radar echoes.

"Movements and Patterns of Development of Thunderstorms," C. W. Newton and J. Fankhauser (181:33).

Emphasis is placed upon determination of the most probable movements of hazardous convective storms. Case studies of large, medium, and small storms, observed with 10-cm WSR-57 radars, are presented, particular attention being given to the development and movement of squall-line echoes. Numerous PPI and RHI profiles, traces of echo movement, and synoptic weather maps are given, along with correlation curves showing direction of echo and storm movement vs. mean wind direction and echo speed vs. reflectivity.

"Some Relations Between Thunderstorm Radar Echoes and Surface Wind Fields," A. B. Arnett (32:1).

It is shown that surface wind patterns can be related to various characteristics of the outlines and movements of radar echoes, and that general areas of surface divergence can be related to specific areas of the echo. Radar echoes and related wind gusts for one case are discussed in great detail; the relation of this "gust front" to radar echo varied in both time and space.

"Analysis of the Severe Weather Factor in Automatic Control of Air Route Traffic," W. B. Beckwith (67:23).

A study of the effect of two severe squall lines on air traffic control. Thunderstorm-echo features observed on a 10-cm WSR-57 radar are confirmed by comparison with airborne radar observations, cloud photographs, and flight logs of aircraft. Numerous maps of air routes are presented with superimposed radar-echo patterns and locations of tornadoes, hail, and heaviest precipitation; it is noted that tornadoes are usually generated in the peripheral areas of strong echoes.

6319 Final Report on NASA Project R-55, "National Severe Storms Project," J. T. Les, Aug 63, (128:12), Unclassified, AD 433 911.

The only portion of this report pertinent to radar reflection is a 56-page attachment, entitled "Thunderstorm Turbulence Measurements by Aircraft and Con-Current Radar Evaluations," which is included in the Final Report (preceding abstract).

WHITE SANDS MISSILE RANGE

6320 "Accuracy and Information Rate Studies on Target Cross Sections Utilizing the Nike Hercules Radars," G. E. Galos, 64, (14:0), Unclassified, AD 612 161.

The Nike Hercules target tracking radar, a monopulse X-band system, is examined as an instrumentation radar for obtaining cross-sections of ballistic missiles in flight on a short range. In particular the accuracy and data rates obtainable for this application are discussed. The studies indicate that log pulse height information at the repetition rate of the radar must be used in order to determine the detailed statistical characteristics of missile targets. On the other hand, long-term (order of 1 second) average characteristics can be determined from AGC data alone. The overall accuracy of the cross-section determination is dependent on range and SNR.

Note: This is a reprint of a paper in the Proceedings of the 1964 Army Science Conference, West Point, New York, 17-19 June 1964.

WOODS HOLE OCEANOGRAPHIC INSTITUTION

6321 Technical Report Reference 62-39, "Detecting Sea Waves by Their Diffraction of a Radio Wave," N. F. Barber, Nonr-3351(00), Sep 62, (70:0), Unclassified, AD 291 464.

This report is concerned with the possibility that the sea state of the ocean surface can be determined by observing the diffraction of low-frequency radio energy. A pulsed transmitter would transmit at each of a number of bearings while slowly sweeping in frequency from, say, 1 to 10 Mc and recording echo strength. Any periodic pattern in the wave structure parallel to the direction of propagation will cause coherent backscatter as observed by D. D. Crombie (Nature 175, 681 (16 Apr 55)). Thus, the record of echo power vs. frequency would be in effect a spatial spectrum of wave structure in that direction. Both shore-station and airborne observations are suggested; in the latter case a trailing wire about 4000 ft long is required as antenna. An earlier paper by the author (New Zealand J. Sci. 2, 99-108 (1959)) describes a suggested airborne system and it is inferred that field tests were conducted; however, this report does not contain any experimental data.

ACTA PHYSICA AUSTRIACA (AUSTRIA)

7001J "Theory of Multiple Scattering," R. Sexl, 14, No. 2, 180-84 (1961). (SA-61-19029)

ACTA PHYSICA POLONICA (POLAND)

7002J "A Not Hitherto Considered Case in Which Kirchhoff's Formulation for the Approximate Description of Diffraction Phenomena Fails," A. Rubinowicz, 17, No. 1, 13-20 (1958). (SA-60-6944)

7003J "On Kottler's Theory of Diffraction," B. Karczewski, 20, Nos. 5/6, 411-23 (1961). (SA-61-19028)

7004J "Reciprocity Theorems and Babinet's Principle in Kirchhoff's Theory of the Diffraction of Electromagnetic Waves," A. Kujawski, 21, No. 6, 597-607 (Jun 62). (SA-62-20150)

7005J "On the Evaluation of Certain Integrals and Their Application to Diffraction Theory," N. Chako, 24, No. 5, 611-20 (Nov 63). (SA-64-24836)

7006J "Diffraction of Electromagnetic Waves by Circular Apertures and Discs. Integral Representation Method. I.," N. Chako, 24, No. 5, 621-27 (Nov 63). (SA-64-24837)

7007J "On Kirchhoff's Solutions of Electromagnetic Diffraction Problem," A. Kujawski, 25, No. 1, 7-19 (Jan 64). (SA-64-24835)

ACTA PHYSICA SINICA (CHINA)

7008J "The Scattering of an Arbitrary Uniform Plane Electromagnetic Wave by an Infinite Metal Rod of Elliptical Cross-Section in an Infinite Homogeneous Isotropic Medium with Finite Conductivity," J. Lang, 17, 321-28 (Jul 61). (SA-63-17052)

ACTA POLYTECHNICA SCANDINAVICA (SWEDEN)

7009J "Investigations of Radio Reflections from Satellite-Produced Ion Trails Using 100 Mc CW Radar," M. Tiuri, Ph 12 (295), 47 pp (1961). (I-61-4265)

ACTA TECHNICA CSAV (CZECHOSLOVAKIA)

7010J "The Reflection of Electromagnetic Waves and Synthesis of Media," P. Beckmann, 1, No. 4, 251-70 (1956). (SB-57-6190)

7011J "A New Approach to the Problem of Reflection from a Rough Surface," P. Beckmann, 2, No. 4, 311-55 (1957). (SB-58-4927)

7012J "The Depolarisation of Electromagnetic Waves Scattered from Rough Surfaces," 6, No. 6, 511-23 (1961). (I-62-3627)

ACUSTICA

7013J "Related Experiments with Sound Waves and Electromagnetic Waves," W. E. Kock, 9, 227-38 (1959). (SA-61-199)

7014J "The Analogy of Acoustic and Electromagnetic Boundary-Value Problems," H. Severin, 9, 270-74 (1959). (SA-61-200)

7015J "Model Experiments on Electromagnetic Reflected Beam Direction Finding (Radar) Using Ultrasonic Waves (Sonar)," E. Meyer and P. Schnupp, 10, No. 1, 1-13 (1960). (SA-61-8190)

ACUSTICA (CONT.)

7016J "A Mechanism of Acoustic Echo Formation," A. Freedman, 12, No. 1, 10-21 (1962). (SA-62-13411)

7017J "The High Frequency Echo Structure of Some Simple Body Shapes," A. Freedman, 12, No. 2, 61-70 (1962). (SA-62-13412)

AERONAUTICAL ENGINEERING REVIEW

7018J "Vertical Scanning Air-Borne Radar for Reducing Hazards of Aircraft Icing and Ground Collisions," L. J. Battan, 15, 52-54 (Dec 56). (MG-57-8.11-74)

AIAA JOURNAL

7019J "Radar Determination of Lunar Surface Dielectric Properties," H. S. Hayre, 1, 2655-656 (Nov 63). (I-A63-25719)

7020J "Back-Scattering Properties of Moon and Earth at X Band," H. Safran, 2, 100-101 (Jan 64). (I-A64-13137)

7021J "Broadside Radar Echoes from Ionized Trails," H. Weil, 2, 429-32 (Mar 64). (I-A64-15124)

7022J "Scattering and Absorption of Plane Waves by Cylindrically Symmetrical Underdense Zones," F. A. Albini, 2, 524-30 (Mar 64). (I-A64-15122)

7023J "Scattering of Radar Waves by an Underdense Turbulent Plasma," J. Menkes, 2, 1154-156 (Jun 64). (I-A64-12955; I-A64-19115)

AKADEMIIA NAUK SSSR, DOKLADY (USSR) [Cover-to-Cover Translation]

7024J "Resonance at the Surface of a Reflection Grating," L. I. Deryugin, 94, No. 2, 203-206 (1954). (SA-57-2444)

7025J "The Excitation, Reflection and Radiation of Surface Waves at a Wedge with Given Impedance Faces," G. D. Malyuzhinets, 121, No. 3, 436-39 (1958). (SA-60-298)

7026J "Radio Echoes from Some Invisible Objects in the Troposphere," A. G. Gorelik and V. V. Kostarev, 125, No. 1, 59-61 (Mar 59). (SA-59-13515; ET-59-2240; TT-61/2-61-16544)

7027J "Fluctuations of Phase-Fronts in the Propagation of Ten-Centimetre Radio-Waves Over the Sea-Surface," A. V. Men', S. Ya. Braude, and V. I. Gorbach, 125, No. 5, 1019-1022 (Apr 59). (SA-60-300; ET-59-2738)

7028J "Integral Equation of the Second Kind for the Problem of Diffraction by an Infinitely Thin Screen," A. Ya. Povzner and I. V. Sukharevskii, 127, No. 2, 291-94 (Jul 59). (SA-59-13509)

7029J "Diffraction of Electromagnetic Waves from Strips of Finite Width," G. A. Grinberg, 129, No. 2, 295-98 (Nov 59). (SA-60-1205)

7030J "Diffuse Irradiation in a Medium with Mirror Reflecting Boundaries," V. V. Sobolev, 136, 571-74 (Jan 61). (I-61-6553)

7031J "The Problem of Scalar Diffraction for an Elliptic Cylinder and an Ellipsoid of Revolution," N. D. Kazarinov, 138, 759-62 (Jun 61). (I-62-471)

7032J "The Fluctuation Spectrum of a Radar Signal and the Velocity Distribution of Scattering Particles," A. G. Gorelik and Iu. V. Mel'nichuk, 140, 579-82 (Sep 61). (I-62-2845)

AKADEMIIA NAUK SSSR, DOKLADY (USSR) (CONT.)

7033J "Application of Elliptically Polarized Radiowaves to the Study of Cloud Formation and Precipitation," A. B. Shupiatskii and S. P. Morgunov, 140, 591-94 (Sep 61). (I-62-2847)

7034J "Reduction of Some Three-Dimensional Problems in Diffraction to the Dirichlet Problem for Laplace's Equation," V. A. Borovikov, 144, No. 3, 527-30 (May 62). (SA-62-21796)

7035J "Two-Dimensional Problem of Diffraction by a Polygon," V. A. Borovikov, 144, No. 4, 743-46 (Jun 62). (SA-62-21797)

7036J "A Short-Wave Asymptote in the Problem of Diffraction from a Convex Body," V. S. Buslaev, 145, No. 4, 753-56 (Aug 62). (SA-63-495)

7037J "Radar Observations of Venus," V. A. Kotel'nikov, V. M. Dubrovin, M. D. Kislik, et al., 145, No. 5, 1035-1038 (Aug 62). (SA-63-9272; I-62-11057; ET-62-4033)

7038J "The Method of Separation of Variables in the Problem of Scattering by a Body of Arbitrary Shape," R. G. Barantsev, 147, No. 3, 569-70 (Nov 62). (SA-63-5366; I-A63-17907)

7039J "Radar Probe of the Planet Mercury," V. A. Kotel'nikov, G. Ia. Gus'kov, V. M. Dubrovin, et al., 147, 1320-322 (Dec 62). (I-A63-12262; I-A63-19053)

7040J "The Three-Dimensional Problem of Diffraction by a Prism," V. A. Borovikov, 148, No. 3, 545-48 (Jan 63). (SA-63-19017; I-A63-18942)

7041J "Radio-Astronomical High-Resolution Observations of Venus," D. V. Korol'kov, Iu. N. Pariiskii, G. M. Timofeeva, and S. E. Khaikin, 149, 65-67 (Mar 63). (I-A63-14591)

7042J "The Method of Group Integrals in Scattering Problems," O. A. Germogenova, 149, No. 1, 76-79 (Mar 63). (SA-63-14367)

7043J "Radar Observations of Venus in the Soviet Union in 1962," V. A. Kotel'nikov, V. M. Dubrovin, B. A. Dubinskii, et al., 151, 532-35 (Jul 63). (I-A63-23922; I-A64-12884)

7044J "Radar Studies of Planet Mars in the Soviet Union," V. A. Kotel'nikov, V. M. Dubrovin, B. A. Dubinskii, et al., 151, 811-14 (Aug 63). (I-A63-25429; I-A64-15380)

7045J "The Diffraction of Surface Waves by a Perfectly Conducting Wedge," S. S. Kalmykova and V. I. Kurilko, 154, No. 5, 1066-1068 (Feb 64). (SA-64-19221)

7046J "Radar Observations of the Planet Jupiter," V. A. Kotel'nikov, L. V. Apraksin, V. M. Dubrovin, et al., 155, 1037-38 (Apr 64). (I-A64-27577; I-A65-10044)

7047J "Estimates of the Field in the Dark Region in the Diffraction of a Cylindrical Wave by a Bounded Convex Cylinder," I. V. Olimpiev, 156, No. 5, 1068-71 (Jun 64). (SA-64-29516; I-A64-27727; I-A65-14782)

7048J "Some Results of the Measurements of Turbulence in a Free, Clear Atmosphere by Radar," A. A. Zagorodnikov, 156, 1336-38 (Jun 64). (I-A64-27787)

AKADEMIIA NAUK SSSR, MEZHDUVEDOMSTVENNYI KOMITET PO PROVEDENIIU MGG (USSR)

7049J "Radar Reflections During Geomagnetic Disturbances," A. I. Grachev, No. 2-3, 19-23 (1960). (MG-62-13.3-385)

7050J "The Connection of Radar Reflections from Auroras with the Disturbances of the Geomagnetic Field of the Earth," V. I. Pogorelov, No. 2-3, 28-31 (1960). (MG-62-13.7-209)

AKADEMIIA NAUK SSSR, MEZHDUVEDOMSTVENNYI KOMITET PO PROVEDENIIU MGG (USSR) (CONT.)

7051J "Radar Reflections from Auroras and Their Connection with Magnetic Disturbances," V. I. Iarin, No. 2-3, 37-41 (1960). (MG-62-13.7-203)

AKADEMIIA NAUK SSSR, VESTNIK (USSR)

7052J "Radar Probing of Planets," V. A. Kotel'nikov, 34, 39-43 (Feb 64). (I-A64-20004)

AKADEMIIA NAUK URSR [KIEV], DOPOVIDI (USSR)

7053J "On the Asymptotic Expansion of the Solution of a Boundary Problem of Diffraction Theory," A. I. Kochura, No. 11, 1157-60 (1958) [Trans: LC or SLA 59-22733, AD 228 037]. (TT-60/1-59-22733)

AKADEMIIA NAVUK BSSR [MINSK], VESTSI, SERYIA FIZIKA-TEKHNICHNYKH NAVUK (USSR)

7054J "Diffraction of a Plane Wave by Two Parallel Elliptical Cylinders," E. A. Ivanov, No. 4, 5-13 (1963). (I-A64-14313)

AKUSTICHESKII ZHURNAL (USSR) [Cover-to-Cover Translation]

7055J "Theory of Wave Scattering on Periodically Uneven Surfaces," Yu. P. Lysanov, 4, No. 1, 3-12 (Jan-Mar 58). (ET-59-775)

7056J "Diffraction of a Scalar Wave by a Slit and by a Circular Aperture in a Screen of Arbitrary Thickness," M. V. Butrov, 6, No. 1, 16-22 (1960). (SA-60-19296; ET-61-1799)

7057J "The Scattering of Plane Wave at a Serrated Surface," A. D. Lapin, 9, 47-49 (Jan-Mar 63). (I-A63-20618)

7058J "Diffraction by a Periodic Surface," I. A. Urusovskii, 10, No. 3, 338-46 (Jul-Sep 64). (SA-65-13956)

ALTA FREQUENZA (ITALY)

7059J "High-Frequency Diffraction," L. B. Felsen, 31, 266-67 (42E-46E) (May 62). (SB-63-10068)

7060J "Some Aspects of the Propagation of Microwaves over the Surface of the Sea," P. Quarta, 33, 22-30 (Jan 64). (SB-65-4918)

7061J "Radar Cross Section of Imperfectly Conducting Bodies at Small Wavelengths," P. Uslenghi, 33, 541-46 (129E-134E) (Aug 64). (SB-65-6626)

AMERICAN JOURNAL OF PHYSICS

7062J "Microwave Reflection from Water Spheres," A. L. Aden, 19, 163-67 (Mar 51). (MG-58-9H-1)

ANAIS DA ACADEMIA BRASILEIRA DE CIENCIAS (BRAZIL)

7063J "Diffraction of a Pulse by a Half-Plane, Treated by the Fourier Method," A. M. M. Macedo, 35, No. 1, 37-44 (1963). (SA-63-24470)

ANNALEN DER PHYSIK (GERMANY)

7064J "The Scattering of Scalar Waves by a Paraboloid of Revolution," K. Klante, 3, Nos. 3/4, Series 7, 171-82 (1959). (SA-59-11287)

7065J "The Theory of a Class of Diffraction Problems by Means of Singular Integral Equations," K. Westpfahl, 4, Nos. 6/8, 283-351 (1959). (SA-60-3857)

ANNALEN DER PHYSIK (GERMANY) (CONT.)

7066J "The Sommerfeld Integral and the Solution of Diffraction Problems for Wedge-Shaped Regions," G. D. Malyughinetz, 6, Nos. 1/2, 107-12 (1960). (SA-60-12696)

7067J "The Exact Closed Solution for the Diffraction of a Plane Electromagnetic Wave at a Slot," H. Stöckel, 9, Nos. 5/6, 242-51 (Jul 62). (SA-63-494; ET-62-3999)

7068J "A Particularly Simple Diffraction Problem," W. Braunbek, 11, Nos. 1/6, 8-12 (1963). (SA-64-699)

7069J "The Diffraction of a Plane Electromagnetic Wave at a Single and at Two Perfectly Conducting Half-Planes in the Boundary Plane Between Two Homogeneous, Isotropic Media," H. Stöckel, 12, Nos. 3/4, 156-85 (1963). (SA-64-5809)

7070J "The Diffraction of a Plane Electromagnetic Wave by Two Parallel, Infinitely Long, Ideal Cylinders of Elliptical Cross Section," K. Germey, 13, Nos. 5/6, 237-51 (1964). (SA-64-24838)

ANNALES DE GEOPHYSIQUE (FRANCE)

7071J "Radio Echoes Observed on Sea Swell at the Casablanca Ionospheric Sounding Station," A. Haubert, 14, 368-72 (Jul-Sep 58). (SA-60-8360; ET-59-2724)

7072J "Studies of the Upper Atmosphere from Invercargill, New Zealand: Part I--Characteristics of Auroral Radar Echoes at 55 Mc/s," R. S. Unwin, 15, 377-94 (Jul-Sep 59) [In English]. (SA-60-21326; ET-60-2380)

7073J "Studies of the Upper Atmosphere from Invercargill, New Zealand. II and III," M. Gadsden, 15, 395-402, 403-11 (Jul-Sep 59) [In English]. (SA-60-21327; ET-60-2381)

7074J "Investigation of the Wind Shears in the Lower Ionosphere by Radioelectric Observation of Meteor Trails. I - Theoretical Investigation. [Appendix - Calculation of the Effect of Diversity]," I. Revah, A. Spizzichino, and C. Taieb, 43-50 (Jan-Mar 63). (I-A63-18244)

7075J "Partial Reflection in the D Region of the Ionosphere Observed at Port Aux Francais (Kerguelen Archipelago)," M. Aubry, 73-79 (Jan-Mar 63). (I-A63-18247)

ANNALES DE PHYSIQUE (FRANCE)

7076J "Contribution to the Study of Diffraction of Electromagnetic Waves by Spheres," J. Mevel, 5, Nos. 3/4, Ser. 13, 265-320 (Mar-Apr 60). (SA-60-12695; ET-61-832)

ANNALES DE LA SOCIETE SCIENTIFIQUE DE BRUXELLES, SERIE I (BELGIUM)

7077J "Application of the Angular Momentum Method to a Classical Scattering Problem," R. J. Ballieu, 78, No. 1, 69-89 (1964). (SA-64-24846)

ANNALES DES TELECOMMUNICATIONS (FRANCE)

7078J "The Reflection of V.H.F. Waves by Sharp Variations of Humidity in the Troposphere," P. Beckmann, 12, 184-86 (May 57). (SB-58-420)

7079J "Study of the Interaction of Two Adjacent Spheres Placed in an Electromagnetic Field," J. Mevel, 12, 186-88 (May 57).

7080J "On the Reflection of an Electromagnetic Plane Wave by a Perfectly Conducting Rough Surface," J. P. Schouten and A. T. deHoop, 12, 211-14 (May 57). (SA-58-243)

7081J "Calculation of Reflection Coefficients and Differential Scattering Cross-Sections for Irregular Surfaces," V. Twersky, 12, 213-16 (May 57).

ANNALES DES TELECOMMUNICATIONS (FRANCE) (CONT.)

7082J "On Babinet's Theorem in Electromagnetic Theory," P. Poincelot, 12, 410-14 (Dec 57). (SB-58-5357)

7083J "Influence of Absorption on the Reflection Coefficient of the Ionosphere," P. Poincelot, 14, 54-58 (Mar-Apr 59). (SB-59-7601)

7084J "Diffraction of a Cylindrical (or Plane) Wave by a Parabolic Cylinder with Generatrices Parallel to the Wave," L. Robin, 19, 257-69 (Nov-Dec 64). (I-A65-27280)

ANNALS OF PHYSICS (USA)

7085J "The Scattering of Waves by a Large Sphere for Impedance Boundary Conditions," G. Kear, 6, 102-13 (Jan 59). (SA-59-4848)

7086J "On the Theory of Scalar Diffraction and Its Application to the Prolate Spheroid," N. D. Kazarinoff and R. K. Ritt, 6, 277-99 (Mar 59). (SA-59-7215)

APPLIED OPTICS

7087J "New Backscattering Computation and Tables for Dielectric and Metal Spheres," S. B. Adler and R. S. Johnson, 1, 655-60 (Sep 62). (SA-62-22337; I-62-10196)

7088J "Scattering and Polarization Properties of Water Clouds and Hazes in the Visible and Infrared," D. Deirmendjian, 3, 187-96 (Feb 64). (I-A64-14251)

7089J "The Scattering of Infrared Radiation from Clouds," E. Bauer, 3, 197-202 (Feb 64). (I-A64-14252)

7090J "The Extreme Values of Reflectivity and the Conditions for Zero Reflection from Thin Dielectric Films on Metal," K. C. Park, 3, 877-81 (Jul 64). (SA-64-24380)

7091J "Rayleigh Scattering," V. Twersky, 3, 1150-62 (Oct 64). (SA-65-330)

APPLIED SCIENTIFIC RESEARCH, SECTION B (NETHERLANDS)

7092J "The Back-Scattering from a Circular Loop," R. G. Kouyoumjian, 6, 165-79 (1957).

7093J "On the Theory of Reflection from a Wire Grid Parallel to an Interface Between Homogeneous Media," J. R. Wait, 6, No. 4, 259-75 (1957). (SB-58-1347; ET-57-3273)

7094J "Scattering of Electromagnetic Waves by an Acoustic Disturbance in the Atmosphere," A. Tonning, 6, No. 6, 401-21 (1957). (ET-58-579)

7095J "Theory of Scattering from a Nearly Transparent Anomaly," V. W. Bolie, 6, No. 6, 422-28 (1957). (SB-58-1631; ET-58-574)

7096J "Far Field Scattering from Bodies of Revolution," K. M. Siegel, 7, No. 4, 293-328 (1958). [Comments: K. M. Siegel, R. F. Goodrich, and V. H. Weston, ibid., 8, No. 1, 8-12 (1959)]. (SA-59-4847; SA-60-5404; ET-61-899)

7097J "On the Theory of Reflection from a Wire Grid Parallel to an Interface Between Homogeneous Media. II.," J. R. Wait, 7, No. 5, 355-60 (1959). (SB-59-4704)

7098J "Scattering of a Plane Monochromatic Wave by a System of Strips," K. Saermark, 7, No. 6, 417-40 (1959). (SB-59-5912)

7099J "On the Plane-Wave Extinction Cross-Section of an Obstacle," A. T. deHoop, 7, No. 6, 463-69 (1959). (SA-59-11288; ET-60-3797)

APPLIED SCIENTIFIC RESEARCH, SECTION B (NETHERLANDS) (CONT.)

7100J "Transmission Coefficient for a System of Parallel Slits in a Thin, Plane Screen," K. Saermark, 8, No. 1, 29-34 (1959). (ET-61-510)

7101J "Diffraction by an Imperfectly Conducting Half-Plane at Oblique Incidence," T. B. A. Senior, 8, No. 1, 35-61 (1959). (SA-60-5403; ET-61-506)

7102J "A Reciprocity Theorem for the Electromagnetic Field Scattered by an Obstacle," A. T. deHoop, 8, No. 2, 135-40 (1960). (SA-60-7223; ET-60-4189)

7103J "Scattering of Electromagnetic Waves by Coaxial Ferrite Cylinders of Different Tensor Permeabilities," Y. Chow, 8, No. 4, 290-98 (1960). (SA-61-16566)

7104J "Impedance Boundary Conditions for Imperfectly Conducting Surfaces," T. B. A. Senior, 8, Nos. 5/6, 418-36 (1960). (SA-61-16559)

7105J "Impedance Boundary Conditions for Statistically Rough Surfaces," T. B. A. Senior, 8, Nos. 5/6, 437-62 (1960). (SA-61-16560; ET-61-2162)

7106J "A Class of Boundary Value Problems," W. E. Williams, 9, No. 1, 21-34 (1961). (SA-61-15748)

7107J "Near-Zone Back-Scattering from Large Spheres," V. H. Weston, 9, No. 2, 107-16 (1961). (SA-61-16567; ET-61-2922)

7108J "High-Frequency Diffraction by a Wedge with a Linearly Varying Surface Impedance," L. B. Felsen, 9, No. 3, 170-88 (1961). (SA-62-5472; I-62-2557; ET-62-1220)

7109J "Some Diffraction Patterns of an Absorbing Half-Plane," C. J. Marcinkowski, 9, No. 3, 189-98 (1961). (SA-62-5473)

7110J "Low-Frequency Scattering by Cylindrical Bodies," J. Van Bladel, 10, Nos. 3/4, 195-202 (1963). (SA-64-5814)

7111J "Scattering of a Plane Scalar Wave by Fundamental Surfaces with Mixed Boundary Conditions," H. Unz and F. B. Sleator, 10, Nos. 3/4, 344-52 (1963). (SA-64-5021)

7112J "Scattering of Plane Waves from an Infinitely Long Cylinder of Anisotropic Materials at Oblique Incidence with an Application to an Electronic Scanning Antenna," S. N. Samaddar, 10, Nos. 5/6, 385-411 (1963-64). (SB-64-9654)

7113J "Electromagnetic Scattering from a Radially Inhomogeneous Sphere," J. R. Wait, 10, Nos. 5/6, 441-50 (1963-64). (SA-64-19229)

ARCHIV DER ELEKTRISCHEN UBERTRAGUNG (GERMANY)

7114J "Reflection of Short and Ultra-Short Waves from the Aurora," G. Lange-Hesse, 11, 253-61, 283-88 (Jun-Jul 57). (SB-57-5891; MG-61-12A-126; ET-58-582)

7115J "The Reflection and Screening Effects of Metallic Enclosures in a Plane Electromagnetic Wave," H. Kaden, 11, 403-15 (Oct 57). (SB-58-1348; ET-58-2882)

7116J "Observations on Back-Scatter Echoes in Long-Distance Short-Wave Transmissions," H. U. Widdel, 11, 429-39 (Nov 57). (SB-58-1629; ET-58-2867)

7117J "The Various Statements of Kirchhoff's Principle and Their Application to the Diffraction Diagrams of Electromagnetic Waves," G. F. Koch, 14, 77-98 and 132-53 (Feb and Mar 60). (ET-61-509)

7118J "The Reflection of Electromagnetic Waves at a Plane Metal Surface Covered with an Absorbing Layer," R. Unbehauen and H. J. Hoffmann, 14, 521-30 (Dec 60). (SA-62-7737; ET-61-3341)

ARCHIV DER ELEKTRISCHEN UBERTRAGUNG (GERMANY) (CONT.)

7119J "The Scattering Matrix of the Ionosphere," H. Volland, 16, 328-34 (Jul 62). (ET-62-3376)

7120J "On the Probability of Meteor Echoes," R. Eyfrig, H. A. Hess, and K. Rawer, 16, 609-10 (Dec 62). (SB-64-7863)

7121J "Backscatter and Long-Distance Pulse Propagation Investigations Between Lindau [Hartz] and Tsumeb [Southwest Africa]," H. Werle, 17, 121-30 (Mar 63). (SB-64-3992)

7122J "Back and Forward Scatter of a 40.68 Mc/s Carrier Wave on Meteors Extending Up To 500 km," W. Blume, 18, 651-56 (Nov 64). (SB-65-4928)

ARCHIWUM ELEKTROTECHNIKI (POLAND)

7123J "Graphical Method of Calculation of the Coefficients of Reflection from the Surface of the Earth," P. Szulkin, 8, No. 1, 97-102 (1959). (SB-60-8256)

ARKIV FOR FYSIK (SWEDEN)

7124J "Diffraction Patterns of Small Phase Objects Measured in the Microwave Region," O. Bryngdahl, 16, Paper 6, 69-92 (1959). (SA-60-297)

7125J "The Scattering of an Electromagnetic Wave by a Dielectric-Coated Metallic Cylinder," H. Wilhelmsson, 23, Paper 41, 447-60 (1963). (SB-63-4906)

ARKIV FOR GEOFYSIK (SWEDEN)

7126J "Studies of Auroral Reflections in the V.H.F. Band. I. Experimental Investigations, with Special Regard to Time Variations, Fading Rate, Azimuthal Distributions, and Polarization Characteristics," A. Egeland, 4, Paper 6, 103-69 (1962). (SA-63-13803; SA-63-25934)

7127J "Studies of Auroral Reflections in the V.H.F. Band. II. Comparison of Experimental Results with Theoretical Models," A. Egeland, 4, Paper 7, 171-209 (1962). (SA-63-13804; SA-63-25935)

ARCHIVE FOR RATIONAL MECHANICS AND ANALYSIS (GERMANY)

7128J "Diffraction by a Quarter-Plane," J. Radlow, 8, No. 2, 139-58 (1961). (I-62-2893)

7129J "Some Scalar Diffraction Problems for a Spherical Cap," W. D. Collins, 10, 249-66 (1962).

7130J "The Electromagnetic Dipole Fields in Nonhomogeneous Media," P. Werner, 16, No. 1, 1-33 (1964). (I-A64-16948)

ASTRONAUTICA ACTA (AUSTRIA)

7131J "The Radar Appearance of Rotating Corner Reflector," R. J. Davis, 5, No. 1, 1-14 (1959).

ASTRONAUTICS AND AERONAUTICS

7132J "Lidar Detection of CAT," R. T. H. Collis, 2, 52-54 (Dec 64). (I-A65-11494)

ASTRONOMICAL JOURNAL

7133J "Properties of Orbiting Dipole Belts," W. E. Morrow, Jr., and D. C. MacLellan, 66, 109 (Apr 61).

ASTRONOMICAL JOURNAL (CONT.)

7134J "A Radar Investigation of Venus," G. H. Pettengill, H. W. Briscoe, J. V. Evans, et al., 67, No. 4, 181-90 (May 62). (SA-62-13174)

7135J "Venusian and Lunar Radar Depolarization Experiments," G. S. Levy and D. Schuster, 67, No. 5, 320-26 (Jun 62). (SA-62-19350)

7136J "Study of Venus by C.W. Radar," R. L. Carpenter, 69, No. 1, 2-11 (Feb 64). (SB-64-5302)

7137J "Venus Characteristics by Earth-Based Radar," R. M. Goldstein, 69, No. 1, 12-18 (Feb 64). (SB-64-5303)

7138J "Radar Observations of Venus at 38 Mc/Sec.," J. C. James and R. P. Ingalls, 69, No. 1, 19-22 (Feb 64). (SB-64-5304)

7139J "Radar Echoes from Venus at 50 Mc/Sec.," W. K. Klemperer, G. R. Ochs, and K. L. Bowles, 69, No. 1, 22-28 (Feb 64). (SB-64-5305)

7140J "Further Venus Radar Depolarization Experiments," G. S. Levy and D. Schuster, 69, No. 1, 29-33 (Feb 64). (SB-64-5306)

7141J "Radar Scattering from Venus and the Moon," D. O. Muhleman, 69, No. 1, 34-41 (Feb 64). (SB-64-5307)

7142J "Faraday Rotation of Venus Radar Echoes," D. Schuster and G. S. Levy, 69, No. 1, 42-48 (Feb 64). (SB-64-5308)

ASTRONOMICHESKII ZHURNAL (USSR) [Cover-to-Cover Translation]

7143J "The Distribution of Meteor Radio Echoes According to Their Duration," E. I. Fialko, 34, No. 2, 241-46 (1957). (SA-58-5581)

7144J "The Effective Scattering Surface of a Weakened Meteor Trail," F. I. Peregudov, 34, No. 4, 621-24 (1957). (TT-62/2-62-32903)

ASTROPHYSICAL JOURNAL

7145J "The Radio-Wave Scattering Properties of the Solar Corona," W. C. Erickson, 139, 1290-1311 (May 64). (I-A64-21011)

7146J "Radar Evidence of Solar Wind and Coronal Mass Motions," J. H. Chisholm and J. C. James, 140, 377-79 (Jul 64). (I-A64-24642)

ATTI DELL' ACCADEMIA NAZIONALE DEI LINCEI. RENDICONTI. CLASSE DI SCIENZE FISICHE, MATEMATICHE E NATURALI (ITALY)

7147J "Integro-Differential Equations and Babinet's Principle for Plane Screens with Unidirectional Conductivity," G. Toraldo di Francia, 20, 476-80 (Apr 56). (SA-57-556)

7148J "Propagation of Plane Electromagnetic Waves in a Directional Conductor with Variable Direction of Conductivity," C. Banfi, 24, 306-10 (Mar 58). (ET-58-3057)

ATTI DELLA FONDAZIONE GIORGIO RONCHI E CONTRIBUTI DELL' INSTITUTO NAZIONALE DI OTTICA (ITALY)

7149J "Introduction to the Modern Theory of Electromagnetic Diffraction," G. Toraldo di Francia, 11, 503-51 (Nov-Dec 56). (SA-58-6077)

AUSTRALIAN JOURNAL OF PHYSICS

7150J "Low-Latitude Reflections from the Aurora Australis," T. J. Seed and C. D. Ellyett, 11, 126-29 (Mar 58). (ET-58-3466)

7151J "Focusing of Radio Waves Reflected from a Rough Curved Ionosphere," J. D. Whitehead, 13, 621-24 (Dec 60). (SB-61-4247; I-61-4262)

7152J "The Characteristics of Persistent Sporadic Meteor Echoes," J. W. Smith, 14, 89-101 (Mar 61). (I-61-7521; ET-61-3376)

7153J "The Reflection Coefficient of the Night-Time Ionospheric F Region," J. P. McGilvray, 16, 203-15 (Jun 63). (SB-63-10681; I-A63-19388)

7154J "Ionospheric Irregularities and High-Multiple Reflections," G. G. Bowman, 17, 480-89 (Dec 64). (I-A65-16899)

7155J "Preliminary Results of Observations of Aspect-Sensitive Reflections from Irregularities in the F Region," E. M. Swenson, 17, 490-503 (Dec 64). (SB-65-4933; I-A65-16900)

BELL SYSTEM TECHNICAL JOURNAL

7156J "A Reflection Theory for Propagation Beyond the Horizon," H. T. Friis, A. B. Crawford, and D. C. Hogg, 36, 627-44 (May 57). (SB-57-4743)

BRITISH COMMUNICATIONS AND ELECTRONICS

7157J "Research at R. R. E. III - Some Radar Observations of Electrons in the Ionosphere," C. D. Watkins and H. K. Sutcliffe, 10, 848-53 (Nov 63). (I-A64-11512)

BRITISH JOURNAL OF APPLIED PHYSICS

7158J "Bandwidth of a Moon Communication Circuit," J. V. Evans, 12, 406-09 (Aug 61). (SA-61-16576)

7159J "Microwave Absorption by Water in Building Materials," J. B. Hasted and M. A. Shah, 15, 825-36 (Jul 64). (SB-64-10655)

BULETINUL INSTITUTULUI POLITEHNIC DIN IASI (SERIE NOUA) (RUMANIA)

7160J "The Reflection of Radar Signals from the Sun," F. G. Bass and S. Ya. Braude, IV(VIII), Nos. 1/2, 127-33 (1958). (SA-59-5311)

BULLETIN DE L'ACADEMIE POLONAISE DES SCIENCES. CLASSE III: MATHEMATIQUE, ETC. (POLAND)

7161J "A New Method of Solving the Diffraction Problem for a Dipole Field," R. Teisseyre, 4, No. 7, 433-38 (1956). (SB-57-3550)

BULLETIN DE L'ACADEMIE POLONAISE DES SCIENCES. SERIE DES SCIENCES TECHNIQUES (POLAND)

7162J "On the Reflection of Electromagnetic Waves in the Ionosphere with Vertical Sounding," P. Szulkin, 7, No. 1, 65-68 (1959). (SA-59-7217)

7163J "Scattering Cross-Section of a Circular Disk Situated in the Field of a Plane Electromagnetic Wave with a Nonuniform Amplitude Distribution," P. Szulkin, 7, No. 4, 279-83 (1959). (SA-60-301)

BULLETIN DE L'ACADEMIE POLONAISE DES SCIENCES. SERIE DES SCIENCES MATHEMATIQUES, ASTRONOMIQUES ET PHYSIQUES (POLAND)

7164J "Fraunhofer Diffraction of an Electromagnetic Wave," B. Karczewski, 7, No. 10, 633-38 (1959). (SA-61-370)

7165J "Polarization of Diffracted Electromagnetic Wave," B. Karczewski, 8, No. 8, 541-46 (1960). (SA-61-3059)

7166J "Approximative Formulas for the Diffracted Electromagnetic Wave. I.," B. Karczewski, 8, No. 10, 703-08 (1960). (SA-61-3060)

7167J "Approximate Formulae for the Diffracted Electromagnetic Wave. II.," B. Karczewski, 8, Nos. 11/12, 767-72 (1960). (SA-61-16565)

7168J "Boundary Conditions for Electromagnetic Fields in the Case of Moving Media," A. Skoru'ski, 10, No. 7, 391-95 (1962). (SA-64-661)

7169J "On the Kirchhoff-Young Diffraction Theory of Electromagnetic Waves," A. Kujawski, 11, No. 2, 67-72 (1963). (SA-63-19445)

BULLETIN OF THE AMERICAN METEOROLOGICAL SOCIETY

7170J "Radar-Scope Interpretations of Wind, Hail and Heavy Rain Storms Between May 27 and June 8, 1954," G. E. Stout and H. W. Hiser, 36, 519-27 (Dec 55). (ET-57-1089)

7171J "Use of Chaff for Wind Measurements," L. J. Battan, 39, 258-60 (May 58). (MG-58-9H-8)

7172J "Development of a Pre-Assembled Radar-Reflective Balloon," B. A. Nickerson, 39, 659 (Dec 58). (MG-60-11H-115)

7173J "A Radar Pattern Associated with Tornadoes," R. H. Nolen, 40, 277-79 (Jun 59). (SB-59-5591; MG-60-11H-117)

7174J "Radar-Echo Enhancement at Frontal Boundaries by Refractive Index Inhomogeneities," J. Schuetz, 40, 295-300 (Jun 59). (SB-59-5592; MG-61-12.9-104)

7175J "Smoke Observations on a 10-cm Radar," H. W. Hiser, 42, 621-25 (Sep 61).

7176J "A Survey of Recent Cloud Physics Research in the Soviet Union," L. J. Battan, 44, 755-71 (Dec 63). (I-A64-13453)

BULLETIN OF THE ELECTROTECHNICAL LABORATORY (JAPAN)

7177J "Diffraction of Electromagnetic Wave by Semi-Infinite Coaxial Cylinders of Unequal Length (Concave-End Type)," K. Takahashi, 25, No. 12, 881-906 (1961). (SB-62-12424)

BULLETIN DES SCHWEIZERISCHEN ELECTROTECHNISCHEN VERCINS (SWITZERLAND)

7178J "Diffraction of a Plane Electromagnetic Wave at a Circular Ferrite Cylinder," W. Eggimann, 52, 377-81 (May 61). [German version of Trans. IRE Microwave Theory and Tech., MTT-8, 440-45 (Jul 60)]. (ET-61-4071)

BULLETIN OF THE TOKYO INSTITUTE OF TECHNOLOGY (JAPAN)

7179J "Microwave Absorbers and Its Synthesis," K. Suetake and Y. Naito, No. 55, 35-42 (1963). (I-A64-19895)

7180J "Absorbing Material Using Parallel Resistance Sheets," K. Suetake and J. W. E. Griemsmann, No. 55, 57-72 (1963). (I-A64-19896)

CAHIERS DE PHYSIQUE (FRANCE)

7181J "On the Interpretation of Huygens' Principle: The Case of Acoustic, Elastic and Electromagnetic Waves," P. Boillet, 11, 59-87 (Feb 57). (SA-58-543)

7182J "On the Interpretation of Huygens' Principle: Acoustic, Elastic, and Electromagnetic Waves. II.," P. Boillet, 11, 238-68 (Jun 57). (SA-59-1179)

CANADIAN JOURNAL OF PHYSICS

7183J "Diffraction of 3.2 cm Electromagnetic Waves by Dielectric Rods. III. Lucite 1 1/2 in. Diameter Semicylinder, Fields Very Close to Surface," C. E. Jordan and A. B. McLay, 35, 1253-64 (Nov 57). (SA-58-4179; ET-58-1394)

7184J "Absorption in a Dielectric Slab," M. P. Bachynski, 36, 456-61 (Apr 58). (SB-58-5852)

7185J "Analysis of Meteoric Body Doppler Radar Records Taken During a Gemini Shower Period," M. S. Rao, 36, 840-54 (Jul 58).

7186J "Scattering from a Small Anisotropic Ellipsoid," R. A. Hurd, 36, 1058-71 (Aug 58). (SA-59-475; ET-59-413)

7187J "Investigation of the Drifts of the Effective Point of Radio Reflection Along a Meteor Train," M. S. Rao and R. L. Armstrong, 36, 1601-23 (Dec 58). (SA-59-2006; ET-59-2226)

7188J "Horizontal Motions in Radar Echoes from Aurora," G. F. Lyon and A. Kavadas, 36, 1661-71 (Dec 58). (SA-59-2005; MG-60-11H-101; ET-59-2255)

7189J "A Note on the Scattering of a Plane Electromagnetic Wave by a Small, Thin-Walled, Cylindrical Dielectric Tube," J. Y. Wong, 37, 77-78 (Jan 59). (SB-59-3804; ET-59-2540)

7190J "The Nose-On Radar Cross-Sections of Conducting Right Circular Cones," J. E. Keys and R. I. Primich, 37, 521-22 (Apr 59). (SB-59-3843; ET-59-3320)

7191J "The Nose-On Radar Cross-Sections of Finite Cones," H. Brysk, R. E. Hiatt, V. H. Weston, and K. M. Siegel, 37, 675-79 (May 59). (SB-59-6787; ET-59-4073)

7192J "Polarization of Radar Echoes from Aurora," A. Kavadas and D. G. Glass, 37, 690-97 (Jun 59). (SA-59-9098; ET-59-4064)

7193J "The Scattering of Electromagnetic Waves by a Corrugated Sheet," T. B. A. Senior, 37, 787-97 (Jul 59). [Comments: L. B. Felsen, ibid., 37, 1563-65 (Dec 59). Correction: ibid., 37, 1572 (Dec 59)]. (SA-59-9877; SA-60-5405; ET-60-110)

7194J "On the Diffraction of Electromagnetic Pulses by Curved Conducting Surfaces," J. R. Wait and A. M. Conda, 37, 1384-96 (Dec 59). (SA-60-1206; ET-60-2694)

7195J "A Note on Diffraction by an Infinite Slit," R. F. Millar, 38, 38-47 (Jan 60). (SA-60-2440)

7196J "The Radar Cross Section of a Semi-Infinite Body," H. Brysk, 38, 48-56 (Jan 60). (SB-60-1878; ET-60-2021)

7197J "Diffraction by a Spheroid," B. R. Levy and J. B. Keller, 38, 128-44 (Jan 60). (SA-60-2442)

7198J "Diffraction by a Unidirectionally Conducting Half-Plane," R. A. Hurd, 38, 168-75 (Feb 60). (SA-60-2441; ET-60-3062)

CANADIAN JOURNAL OF PHYSICS (CONT.)

7199J "The Scattering of a Plane Wave by a Row of Small Cylinders," R. F. Millar, 38, 272-89 (Feb 60). (SA-60-2210; ET-60-2969)

7200J "An Analysis of Some Statistical Properties of Auroral Radar Reflections and Their Relationships to the Detection Capabilities of the Radar," A. G. McNamara, 38, 425-38 (Mar 60). (SA-60-6479; MG-61-12.4-356; ET-60-3518)

7201J "A Note on Diffraction by a Half Plane," W. E. Williams, 38, 507-10 (Mar 60). (SA-60-6949)

7202J "On the Geometry of Radio Reflections from Aurora," P. A. Forsyth, 38, 593-603 (May 60). (SA-60-10439; ET-60-3516)

7203J "Scattering of Radio Waves by an Ionized Gas in Thermal Equilibrium," J. A. Fejer, 38, 1114-33 (Aug 60). (SB-60-6959; ET-61-1290)

7204J "An Electromagnetic Diffraction Problem Involving Unidirectionally Conducting Surfaces," R. A. Hurd, 38, 1229-44 (Oct 60). (SA-60-17104; ET-61-1800)

7205J "Scattering by a Narrow Unidirectionally Conducting Infinite Strip," S. R. Seshadri, 38, 1623-31 (Dec 60). (SA-61-372; ET-61-2164)

7206J "Scalar Diffraction by a Prolate Spheroid at Low Frequencies," T. B. A. Senior, 38, 1632-41 (Dec 60). (SA-61-371; ET-61-2163)

7207J "Back-Scattering from a Conducting Cylinder with a Surrounding Shell," M. A. Plonus, 38, 1665-76 (Dec 60). (SA-61-373; ET-61-2165)

7208J "Scattering by a Grating: Parts 1 and 2," R. F. Millar, 39, 81-118 (Jan 61). (ET-61-2166)

7209J "Refraction and Diffraction of Pulses," W. E. Williams, 39, 272-75 (Feb 61). (SA-61-4721)

7210J "Analysis of a Type of Rough-Trail Meteor Echo," B. A. McIntosh, 39, 437-44 (Mar 61). (SA-61-5170; I-61-3459; ET-61-2940)

7211J "Models of Auroral Ionization. I-Auroral Ionization Models and Their Radio-Reflection Characteristics. II-Applications to Radio Observations of Aurora," D. R. Moorcroft, 39, 677-715 (May 61). (I-61-6543)

7212J "Scattering of Radio Waves by an Ionized Gas in Thermal Equilibrium in the Presence of a Uniform Magnetic Field," J. A. Fejer, 39, 716-40 (May 61). (SB-61-4255; I-61-6322; ET-61-3525)

7213J "A Note on the Diffraction of a Scalar Wave by a Small Circular Aperture," R. A. Hurd, 39, 1065-70 (Jul 61). (SA-61-18613; ET-61-3725)

7214J "High-Frequency Diffraction by a Sphere," C. L. Tang, 39, 1486-94 (Oct 61). (SA-61-19025; I-61-10268; ET-62-453)

7215J "The Azimuthal Distribution of Ultra-High-Frequency Radar Echoes from Aurora," P. E. Kelly, D. R. Hansen, and P. A. Forsyth, 39, 1535-44 (Nov 61). (MG-62-13.10-200; ET-62-887)

7216J "Transmission and Reflection of Electromagnetic Waves at a Plasma Boundary for Arbitrary Angles of Incidence," K. A. Graf and M. P. Bachynski, 39, 1544-62 (Nov 61). (SA-61-18865; I-62-476; ET-62-801)

7217J "On the Association of Radio Reflections with Optical Aurora," P. A. Forsyth, 39, 1721-24 (Nov 61). (SA-62-2514; I-62-478; ET-62-886)

CANADIAN JOURNAL OF PHYSICS (CONT.)

7218J "Radar Angels in the Lower Troposphere," D. R. Hay and W. M. Reid, 40, 128-38 (Jan 62). (SA-62-3173; MG-62-13.8-515; ET-62-1290)

7219J "Specular Echoes from Dense Meteor Trails," H. Brysk, 40, 393-401 (Apr 62). [Comments: L. A. Manning, ibid., 41, 704-05 (Apr 63)]. (SA-62-11162; SA-63-16427; ET-62-2294)

7220J "The Effect of Absorption and Multiple Scattering on Radio-Auroral Observations," G. F. Lyon, 40, 739-48 (Jun 62). (SB-62-11316; ET-62-3033)

7221J "Radio-Auroral Reflection Mechanisms," G. F. Lyon and P. A. Forsyth, 40, 749-60 (Jun 62). (SB-62-11317; I-62-8073; ET-62-3034)

7222J "Wave Propagation Around a Curved Boundary Which Contains an Obstacle," J. R. Wait, 40, 1010-16 (Aug 62). (SA-62-17956)

7223J "Scattering from a Cylinder Coated with an Inhomogeneous Dielectric Sheath," C. Yeh and Z. A. Kaprielian, 41, 143-51 (Jan 63). (SA-63-7703)

7224J "Experimental Study of the Amplitude of Radar Meteor-Head Echoes," B. A. McIntosh, 41, 355-71 (Feb 63). (SA-63-9273; I-A63-12497)

7225J "An Experimental Technique for Studying Reflection Coefficients of Tropospheric Inhomogeneities," D. R. Hay and F. H. Fanaki, 41, 563-67 (Mar 63). (SB-63-6938; I-A63-13701)

7226J "Diffraction by a Conducting Circular Cylinder Clad by an Anisotropic Plasma Sheath," Y. Ohba, 41, 881-89 (Jun 63). (SA-63-19446; I-A63-18523)

7227J "The Occurrence and Characteristics of Radar Auroral Echoes at 488 and 944 Mc/s," B. C. Blevis, J. W. B. Day, and O. S. Roscoe, 41, 1359-80 (Aug 63). (SA-63-21068; I-A63-22885)

7228J "The Fresnel Field in Kottler's Diffraction Theory," B. Karczewski, 41, 1623-29 (Oct 63). (SA-64-698)

7229J "Plane Wave Spectra in Grating Theory. I. Scattering by a Finite Number of Bodies," R. F. Millar, 41, 2106-34 (Dec 63). (SA-64-5398)

7230J "Plane Wave Spectra in Grating Theory. II. Scattering by an Infinite Grating of Identical Cylinders," R. F. Millar, 41, 2135-54 (Dec 63). (SA-64-5399)

7231J "Observations Upon Clear-Air Stratification in the Lower Troposphere," M. B. Bell, D. R. Hay, and R. W. Johnston, 42, 273-86 (Feb 64). (SA-64-17877)

7232J "Nonlinear Propagation of Electromagnetic Waves in Magnetoplasmas. II.," M. S. Sodha and G. J. Palumbo, 42, 349-63 (Feb 64). (SB-64-6358)

7233J "Scattering by a Perfectly Conducting Cylinder in a Compressible Plasma," S. R. Seshadri, I. L. Morris, and R. J. Mailloux, 42, 465-76 (Mar 64). (SA-64-14669; I-A64-15372)

7234J "Scattering by a Perfectly Conducting Cylinder in a Gyroelectric Medium: Numerical Results," S. R. Seshadri, 42, 860-72 (May 64). (SA-64-19228; I-A64-18715)

7235J "Plane Wave Spectra in Grating Theory. III. Scattering by a Semi-Infinite Grating of Identical Cylinders," R. F. Millar, 42, 1149-84 (Jun 64). (SA-64-21655)

7236J "Diffraction by a Conducting Half-Plane in an Anisotropic Plasma," E. V. Jull, 42, 1455-68 (Aug 64). (SA-64-27644; I-A64-23533)

CANADIAN JOURNAL OF PHYSICS (CONT.)

7237J "The Distribution of Ionization Along Underdense Meteor Trails," D. W. Rice and P. A. Forsyth, 42, 2035-47 (Nov 64). (I-A65-10961)

7238J "High-Frequency Scattering from a Coated Cylinder," P. L. E. Uslenghi, 42, 2121-28 (Nov 64). (SA-65-2258; I-A65-10964)

7239J "Plane Wave Spectra in Grating Theory. IV. Scattering by a Finite Grating of Identical Cylinders," R. F. Millar, 42, 2395-2410 (Dec 64). (SA-65-4717)

CHALMERS TEKNISKA HOGSKOLANS HANDLINGAR (SWEDEN)

7240J "On the Origin of Radar Echoes Associated with Auroral Activity," J. Meos and S. Olving, No. 196, 20 pp (1958). (SA-58-4564; MG-61-12A-162; ET-61-567)

COMMUNICATIONS AND ELECTRONICS

7241J "Measurement of the Scattering Matrix with an Intervening Ionosphere," H. Brysk, No. 39, 611-12 (Nov 58). (ET-59-1345)

7242J "Moon Reflection Studies with Bistatic Radar at 3000 Mc/s," A. W. Straiton and C. W. Tolbert, No. 50, 436-40 (Sep 60). (SB-61-3499; ET-61-1150)

7243J "A New Method of Space Exploration by Radar, Using Incoherent Scattering," T. Laaspere, No. 58, 557-60 (Jan 62). (SB-62-8257)

COMMUNICATIONS ON PURE AND APPLIED MATHEMATICS

7244J "Asymptotic Formulas for Diffraction by Parabolic Surfaces," H. Hochstadt, 10, 311-29 (Aug 57). (ET-58-424)

7245J "Diffraction of a Skew Plane Electromagnetic Wave by an Absorbing Right-Angled Wedge," F. C. Karal, Jr., and S. N. Karp, 11, 495-533 (Nov 58). (ET-59-3266)

7246J "Diffraction by a Smooth Object," B. R. Levy and J. B. Keller, 12, 159-209 (Feb 59). (ET-59-3265)

7247J "Diffraction by an Imperfectly Conducting Wedge," T. B. A. Senior, 12, 337-72 (May 59). (ET-59-4028)

7248J "Scattering of a Surface Wave by a Discontinuity in the Surface Reactance on a Right-Angled Wedge," F. C. Karal, Jr., S. N. Karp, T. S. Chu, and R. G. Kouyoumjian, 14, 35-48 (Feb 61). (ET-61-3346)

7249J "Diffraction by an Elliptic Cone," L. Kraus and L. M. Levine, 14, 49-68 (Feb 61). (ET-61-3344)

7250J "Diffraction of Scalar Waves by a Circular Aperture--II," J. Bazer and H. Hochstadt, 15, 1-33 (Feb 62).

COMPTES RENDUS HEBDOMADAIRES DES SEANCES DE L'ACADEMIE DES SCIENCES (FRANCE)

7251J "Influence of Collisions on Ionospheric Reflection," P. Poincelot, 244, No. 15, 2031-33 (Apr 57). (SA-57-8031)

7252J "On Ionospheric Reflection in the Presence of Collisions," P. Poincelot, 244, No. 18, 2298-99 (Apr 57). (SA-57-9283)

7253J "The Reflection Coefficient of Ionospheric Layers," G. Pillet, 245, No. 3, 335-38 (Jul 57). (ET-58-780)

7254J "Contribution of Partial Atmospheric Reflections to the Explanation of the Field Received at Great Distances," F. du Castel and P. Misme, 246, No. 1, 82-84 (Jan 58). (ET-58-3956)

COMPTES RENDUS HEBDOMADAIRES DES SEANCES DE L'ACADEMIE DES SCIENCES (FRANCE) (CONT.)

7255J "The Fluctuation of Precipitation Echoes," R. Lhermitte, 246, No. 8, 1245-48 (Feb 58). (MG-59-10.1-160)

7256J "Reflection of an Electromagnetic Wave by an Atmospheric Layer Having a Variation of the Refractive Index," F. du Castel, P. Misme, and J. Voge, 246, No. 12, 1838-40 (Mar 58). (SA-58-4186; MG-59-10.1-342; ET-58-3955)

7257J "The Edge Condition in Diffraction Problems," P. Poincelot, 246, No. 24, 3324-25 (Jun 58). (ET-58-774)

7258J "Diffraction of a Plane Electromagnetic Wave by a Semi-Infinite Perfectly Conducting Sheet," P. Poincelot, 246, No. 25, 3418-19 (Jun 58). (SA-58-8945)

7259J "On the Boundary Condition at Edges," P. Poincelot, 247, No. 25, 2312-13 (Dec 58). (SA-59-3668)

7260J "Absorbing Thin Layers: The Problem of Optimum Thickness in Connection with a Classification of These Films," M. Gourceaux, 248, No. 3, 392-94 (Jan 59). (SA-59-8901; ET-59-3268)

7261J "Direct Representation of the Fluctuation Spectrum of Radar Echoes from Precipitation," R. Lhermitte, 248, No. 10, 1554-56 (Mar 59). (MG-59-10.10-169)

7262J "Discussion of the Effect of Frequency in the Problem of Finding the Optimum Thickness of Absorption for a Thin Metallic Layer," M. Gourceaux, 248, No. 17, 2461-62 (Apr 59). (SA-59-8902)

7263J "The Exactness of the Solution of a Problem of Diffraction or of Propagation," P. Poincelot, 249, No. 10, 950-51 (Sep 59). (SA-60-1204)

7264J "Generalization of the Condition at an Edge," P. Poincelot, 250, No. 26, 4316-18 (Jun 60). (SA-60-15143)

7265J "Generalization of the Condition at Edges, in the Case of a Twisted Curve," P. Poincelot, 251, No. 23, 2670-71 (Dec 60). (SA-61-5594)

7266J "Total Reflection and Backward Radiation from 'Secondary Sources' According to Huygens' Principle," A. Metz, 252, No. 10, 1429-30 (Mar 61). (SA-61-9466)

7267J "Application of the Method of Spherical Harmonics to the Study of the State of Polarization of Scattered Radiation," J. Lenoble, 252, No. 23, 3562-64 (Jun 61). (SA-61-16117)

7268J "An Elementary Solution in the Theory of Mie," A. Brotas, 255, No. 16, 1871-72 (Oct 62). (SA-63-4249)

7269J "Diffraction of a Cylindrical Electromagnetic Wave by a Perfectly Conducting Parabolic Cylinder. The Case of Horizontal Polarization," L. Robin, 255, No. 19, 2385-87 (Nov 62). (SA-63-4271)

7270J "Diffraction of a Cylindrical Electromagnetic Wave by a Perfectly Conducting Parabolic Cylinder. The Case of Vertical Polarization," L. Robin, 255, No. 21, 2730-32 (Nov 62). (SB-63-5964)

7271J "Diffusion by Reflection of a Plane Wave on an Irregular Surface," J. Pavageau, 256, No. 2, 390-92 (Jan 63). (SA-63-9622)

7272J "Diffraction of Electromagnetic Waves by a Sinusoidal Grating," P. Bousquet and R. Deleuil, 256, No. 7, 1461-64 (Feb 63). (SB-63-8632)

7273J "Diffraction of Electromagnetic Waves by a Grating with Plane Facets [Polygonal Bars]," P. Bousquet, 256, No. 16, 3422-25 (Apr 63). (SA-63-17051)

COMPTES RENDUS HEBDOMADAIRES DES SEANCES DE L'ACADEMIE DES SCIENCES (FRANCE) (CONT.)

7274J "Attempt at a General Method of Introducing the Functions X and Y of Chandrasekhar in the Case of Anisotropic Diffusion," J. Lenoble, 256, No. 22, 4638-40 (May 63). (SA-64-709)

7275J "Diffraction of Electromagnetic Waves by a Grating with Triangular Section Rulings," P. Bousquet, 257, No. 1, 80-83 (Jul 63). (SA-63-24472)

7276J "Diffraction of a Plane Monochromatic Wave by a Perfectly Conducting Periodic Grating," R. Petit, 257, No. 14, 2018-21 (Sep 63). (SA-64-3148)

7277J "Study of the Altitude of Meteoric Echoes Received on a Link by Forward Diffusion," I. Revah, A. Spizzichino, and M. Cohen, 257, No. 25, 3999-4002 (Dec 63). (I-A64-13895)

7278J "Diffraction of a Plane Monochromatic Wave by a Metallic Diffraction Grating," R. Petit, 258, No. 5, 1429-32 (Feb 64). (SA-64-14888)

7279J "Diffusion by Imperfectly Plane Surfaces," J. Pavageau, 258, No. 24, 5828-31 (Jun 64). (SA-64-27654; I-A64-21300)

7280J "Diffraction of a Plane Electromagnetic Wave by an Inhomogeneous Plasma Cylinder," P. E. Faugeras, 259, No. 6, 1311-14 (Aug 64). (SA-65-6004; I-A64-26527)

7281J "Theoretical Consideration of Diffraction by Reflection at Quasiplanar Surfaces with Application to Diffraction at Gratings," A. Wirgin, 259, No. 8, 1486-88 (Aug 64). (SB-65-4205)

7282J "Diffraction, by a Perfectly Conducting Circular Cylinder, of the Radiation from an Electric Dipole Whose Axis is Parallel to that of the Cylinder," L. Robin and P. Poincelot, 259, No. 20, 3451-54 (Nov 64). (SA-65-4953)

7283J "Diffraction by a Perfectly Conducting Circular Cylinder of the Radiation from a Magnetic Dipole Whose Axis is Parallel to that of the Cylinder," L. Robin and P. Poincelot, 259, No. 21, 3693-96 (Nov 64). (SA-65-10542)

7284J "Integro-Differential Equations for Electromagnetic Diffraction," P. Poincelot, 259, No. 22, 3971-74 (Nov 64). (SA-65-14105)

7285J "Diffraction of a Plane Electromagnetic Wave by a Perfectly Conducting, Elliptical Cylinder. A Study of the Divergence of the Series Obtained," L. Robin, 259, No. 25, 4517-20 (Dec 64). (SA-65-14104)

CZECHOSLOVAK JOURNAL OF PHYSICS

7286J "The Scattering of Waves by a Periodic Surface," P. Beckmann, 11, No. 12, 863-70 (1961). (SA-62-5474; I-62-3646)

DEUTSCHE HYDROGRAPHISCHE ZEITSCHRIFT (GERMANY)

7287J "Some Problems in Modelling Water Waves for the Study of Backscattering of Microwave Radio Energy," R. C. Staley, 11, No. 6, 255-58 (1958). (MG-61-12M-812)

ELECTRONIC DESIGN

7288J "Microwave Reflectivity--Theory and Practice," E. F. Buckley, 12-19 (15 Mar 62).

7289J "Stepped-Index Luneberg Lenses: Antennas and Reflective Devices," E. F. Buckley, 86-89 (13 Apr 60).

ELECTRONIC AND RADIO ENGINEER (GB)

7290J "Scattering of Electromagnetic Waves by Long Cylinders," A. W. Adey, 35, 149-58 (Apr 58). (SB-58-2540; ET-58-1706)

7291J "Metal-Flake Artificial Dielectric," S. Swarup, 35, 179-82 (May 58). (ET-58-2111)

7292J "Reflection Coefficients," R. A. Waldron and J. K. Skwirzynski, 36, 464-65 (Dec 59). (SB-60-778; ET-60-748)

ELECTRONICS

7293J "Atmospheric Angels Mimic Radar Echoes," V. G. Plank, 31, No. 11, 140-44 (Mar 58). (SB-58-2738; ET-58-2100)

7294J "Four Ways to Simulate Radar Targets," J. I. Leskinen, 31, No. 23, 82-86 (Jun 58). (SB-58-4445; ET-58-3476)

7295J "Realistic Simulation of Radar Clutter," J. Atkin, H. J. Bikel, and M. Weiss, 32, No. 39, 78-81 (Sep 59). (SB-59-7622; ET-60-173)

7296J "Radar Cross Section Measurements: How Accurate Are They?," L. Solomon, 35, 48-52 (Jul 62). (I-62-8883)

ELECTRONICS AND POWER (JOURNAL OF THE INSTITUTION OF ELECTRICAL ENGINEERS)

7297J "Radar Meteorology," R. F. Jones, 10, 353-57 (Oct 64). (I-A64-27488)

ELECTRONICS RECORD (GB)

7298J "Effect of Weather on Performance of an 8 MM Radar," O. Nourse and S. G. Nicholls, 1523-33 (Oct 64). (I-A64-27765)

ELEKTRONISCHE RUNDSCHAU (GERMANY)

7299J "Behaviour of cm Waves in Rainy Weather," B. Abild, 10, No. 9, 249-52 (Sep 56). (SB-57-3080)

ELEKTROSVYAZ' (USSR) [Cover-to-Cover Translation]

7300J "Incidence of a Plane Wave on a Selective Reflecting Surface," N. V. Talyzin, 15, No. 3, 8-17 (1961). (SB-62-13472; TT-62/1-62-13840)

7301J "Investigation of Directional Properties of the Scattering of Microwave Radio Signals by Meteor Trails," V. F. Chepura, V. L. Kashcheev, and B. G. Bondar, 16, No. 11, 3-10 (Nov 62). (I-A63-19192)

FAIREY REVIEW (GB)

7302J "Towed Targets," Anonymous, 3, 82-86 (Dec 60). (I-61-3495)

FIZIKA (USSR)

7303J "Diffraction of 3.6-cm Electromagnetic Waves by a Slot Whose Width is Comparable to the Wavelength," L. P. Strelkova, No. 3, 161-62 (1964). (I-A64-23844)

FORSCHUNGEN UND FORTSCHRITTE (GERMANY)

7304J "Radar Location of Auroras," K. Sprenger, 35, No. 6, 161-65 (Jun 61). (MG-62-13.3-164)

GEOFYSISKE PUBLIKASJONER. GEOPHYSICA NORVEGICA (NORWAY)

7305J "Investigation of the Scattering of Radio Waves at Metric Wavelengths in the Lower Ionosphere," T. Hagfors, 21, No. 2, 58 pp (1959). (SB-60-3128)

GEOMAGNETIZM I AERONOMIYA (USSR) [Cover-to-Cover Translation]

7306J "Perturbations Produced in a Plasma by a Rapidly Moving Body," L. P. Pitaevskii, 1, No. 2, 194-208 (1961). (I-A63-15891)

7307J "Scattering of Electromagnetic Waves by Inhomogeneities Excited in a Plasma by a Rapidly Moving Body," Ia. L. Al'pert and L. P. Pitaevskii, 1, No. 5, 709-24 (1961). (I-A63-15892)

7308J "Limiting Frequencies at Oblique Incidence for Two Types of E_s," T. S. Kerblai, 2, No. 3, 406-10 (1962). (I-A64-13102)

7309J "Soil Relief Irregularities and Their Influence on the Propagation of Surface Waves," V. E. Kashprovskii and F. A. Kuzubov, 3, No. 3, 525 (1963). (I-A64-15755)

7310J "The Ionospheric Interpretation of the Results of Radar Observations of Venus. I.," A. D. Danilov and S. P. Iatsenko, 3, No. 4, 585 (1963). (I-A64-17023)

7311J "The Ionospheric Interpretation of the Results of Radar Observations of Venus. II.," A. D. Danilov and S. P. Iatsenko, 3, No. 4, 594 (1963). (I-A64-17024)

7312J "Scattering on Moving Inhomogeneities in the Ionosphere," V. A. Checha, 3, No. 4, 778 (1963). (I-A64-17053)

7313J "Anomalous Reflection Coefficient Values," M. Shirmamedov, 3, No. 5, 922 (1963). (I-A64-23708)

7314J "Relationship Between Some Ionospheric Characteristics and Geomagnetic Activity," V. D. Kokourov, 3, No. 5, 995 (1963). (I-A64-23720)

7315J "Distribution Law of the Apparent Radio Wave Reflection Coefficient of the Ionosphere," Iu. V. Berezin, 4, 54-60 (Jan-Feb 64). (I-A64-16998; I-A65-14072)

7316J "Temporal Variation of a Signal Reflected from a Meteor Trail," Iu. K. Kalinin, 4, 124-30 (Jan-Feb 64). (I-A64-17007; I-A65-14081)

7317J "Critical Frequencies Reflected from the Thin E_s Layer in the Case of Incidence at an Angle," T. S. Kerblai, 4, No. 1, 179-80 (1964). (I-A64-17016)

7318J "Resonance Phenomena in Radiowave Scattering on Meteor Trails and Their Models," I. V. Bairachenko, 4, 313-20 (Mar-Apr 64). (I-A65-15744)

7319J "Synchronous Observations of Anomalous Values of the Coefficient of Reflection from the F_2-Region of the Ionosphere Using Scattered Receiving Antennas," M. Shirmamedov, 4, 594-98 (May-Jun 64). (I-A64-21827; I-A65-19364)

7320J "The Phenomenon of Scattered Reflections as an Experimental Basis for the Study of the Inhomogeneous Structure of the Ionosphere," V. D. Kokourov, 4, 598-600 (May-Jun 64). (I-A65-19365)

7321J "Wave Diffraction on a Nonhomogeneous Finite Screen," N. G. Denisov, 4, 675-80 (Jul-Aug 64). (I-A64-28389; I-A65-20836)

7322J "Some Results of an Experimental Investigation of Radio-Wave Absorption in the Ionosphere," Iu. V. Berezin, 4, 681-87 (Jul-Aug 64). (I-A64-28390)

7323J "Radar Probing of the Sun," V. E. Merkulenko, 4, 825-31 (Sep-Oct 64). (I-A64-28540; I-A65-22057)

GEOMAGNETIZM I AERONOMIYA (USSR) (CONT.)

7324J "Spectral Characteristics of a Field with Diffraction on an Irregular Screen," T. A. Gailit and V. D. Gusev, 4, 832-41 (Sep-Oct 64). (I-A64-28541; I-A65-22058)

7325J "Analysis of Fading of a Reflected Signal," V. D. Kokourov, 4, 1064-71 (Nov-Dec 64). (I-A65-26185)

GEOPHYSICS

7326J "Diffraction of Electromagnetic Waves by an Inhomogeneous Sphere," J. G. Negi, 27, No. 4, 480-92 (Aug 62). [Comments: A. Ben-Menahem and A. Cisternas; J. G. Negi, ibid., 28, No. 4, 665; 665-67 (Aug 63)]. (SA-62-20151; SA-64-5811)

GLAVNOI GEOFIZICHESKOI OBSERVATORII IMENI A. I. VOEIKOVA [LENINGRAD], TRUDY (USSR)

7327J "Reflection of Radiation by the Sea in the Presence of Waves," N. Ye. Ter-Markaryants, No. 68, 166-71 (1957). [Trans: OTS PB 141228T]. (TT-59/1-PB-141-228T)

7328J "Reverse Scattering of Radiation by the Sea," N. Ye. Ter-Markaryants, No. 68, 178-80 (1957). [Trans: OTS PB 141228T]. (TT-59/1-PB-141-228T)

7329J "Radar Method for Investigating the Structure of Cumulonimbus Clouds," E. M. Sal'man, No. 82 (1958). (I-62-4963)

7330J "Radar Echoes from Dielectric Inhomogeneities of Thermal Nature," No. 120[182], 37-44 (1961). [Trans: ATS-04N58R]. (TT-62/1-ATS-04N58R)

HOCHFREQUENZTECHNIK UND ELEKTROAKUSTIK (GERMANY)

7331J "Investigation of the Reflection Characteristics of Plane Reflectors in the Decimeter Range," E. Duniss and K. E. Muller, 68, No. 6, 185-90 (Jan 60). (ET-61-46)

7332J "Interference in Radar Equipment by Reflections from Sea Movements," J. Brauns and H. G. Moller, 70, No. 2, 39-46 (May 61). (ET-62-155)

7333J "Diffraction of Centimeter Electromagnetic Waves by Square Diaphragms," H. Kleineberg, 71, No. 2, 65-74 (Apr 62). (SB-62-13470; ET-62-2967)

ICARUS

7334J "The Electrical Characteristics of the Atmosphere and Surface of Venus from Radar Observations," D. O. Muhleman, 1, 401-11 (Apr 63). (I-A63-18557)

7335J "On the Interpretation of Radar Reflections from the Moon," J. V. Evans and T. Hagfors, 3, 151-60 (Jul 64). (I-A64-28019)

7336J "Radar Observations of Venus at 3.6 Centimeters," D. Karp, W. E. Morrow, Jr., and W. B. Smith, 3, 473-75 (Dec 64). (I-A65-17767)

IEEE SPECTRUM

7337J "New Coherent Light Diffraction Techniques," W. H. Huntley, Jr., 1, 114-15, 118-22 (Jan 64). (I-A64-18489)

IEEE TRANSACTIONS ON AEROSPACE

7338J "Spatial Coverage of Radar Reflectors," D. Levine and W. H. Welch, AS-2, No. 2, 160-65 (Apr 64). (SA-64-18095)

IEEE TRANSACTIONS ON AEROSPACE AND NAVIGATIONAL ELECTRONICS

7339J "Inaccuracies in Doppler Radar Navigation Systems Due to Terrain Directivity Effects, Nonzero Beamwidths and Eclipsing," E. Feuerstein, H. Safran, and P. N. James, ANE-11, 101-11 (Jun 64). (SB-64-12822)

7340J "Doppler Radar Clutter," J. L. Farrell and R. L. Taylor, ANE-11, 162-72 (Sep 64). (SB-65-3268)

IEEE TRANSACTIONS ON ANTENNAS AND PROPAGATION

7341J "Low-Frequency Scattering by Rectangular Cylinders," K. Mei and J. Van Bladel, AP-11, 52-56 (Jan 63). (SB-63-4908)

7342J "Diffraction by a Circular Aperture in a Unidirectionally Conducting Screen," S. R. Seshadri and T. T. Wu, AP-11, 56-67 (1963).

7343J "Back-Scatter by Dielectric Spheres (Refractive Index ~ 1.6)," D. Atlas, L. J. Battan, W. G. Harper, et al., AP-11, 68-72 (Jan 63). (SB-63-4909)

7344J "The Scattering Cross Section of a Composite Cylinder, Geometric Optics," R. D. Kodis, AP-11, 86-93 (Jan 63). (SB-63-4911)

7345J "The Computation of Electromagnetic Scattering from Concentric Spherical Structures," J. J. Mikulski and E. L. Murphy, AP-11, 169-77 (Mar 63). (SB-63-7212; I-A63-14173)

7346J "Scattering by Perfectly-Conducting Rectangular Cylinders," K. K. Mei and J. G. Van Bladel, AP-11, 185-92 (Mar 63). [Comments: M. C. Andreasen, ibid., AP-12, 235-36 (Mar 64)]. (SB-63-7213; SB-64-9680)

7347J "A Game Theoretic Method of Obtaining a Given Return from a Minimum Weight of Radar Reflectors," J. Lipford, AP-11, 193 (Mar 63). (SB-63-9148; I-A63-14174)

7348J "Measurement of Diffraction Fields of Finite Cones by a Scattering Technique Using Light Modulation," A. Vural, D. K. Cheng, and B. J. Strait, AP-11, 200-01 (1963).

7349J "Radar Reflectivity of the Ocean Surface for Circular Polarization," I. Katz, AP-11, 451-53 (Jul 63). (SB-63-15919; I-A63-22849)

7350J "On the Radar Cross Section of Rods, Tubes, and Strips of Finite Conductivity," C. W. Harrison, Jr., and R. O. Heinz, AP-11, 459-68 (Jul 63). (SB-63-13973; I-A63-22851)

7351J "Backscattering Measurements by an F.M. Radar Method," M. Matsuo, AP-11, 485-89 (Jul 63). (SB-63-13974; I-A63-22853)

7352J "Diffraction by a Perfectly Conducting Semi-Infinite Screen in an Anisotropic Plasma," S. R. Seshadri and A. K. Rajagopal, AP-11, 497-502 (Jul 63). (SB-63-13201; I-A63-22855)

7353J "The Effect of Fins on the Nose-On Cross Section of a Cone-Sphere," E. F. Knott and T. B. A. Senior, AP-11, 504-05 (Jul 63). (SB-63-15920; I-A63-22857)

7354J "Scattering from a Gyrotropic Cylinder," J. C. Palais, AP-11, 505-06 (Jul 63). (SA-64-711; I-A63-22858)

7355J "H.F. and V.H.F. Radio Wave Attenuation Through Jungle and Woods," S. Krevsky, AP-11, 506-07 (Jul 63). (SB-63-15865)

7356J "Radar Cross Sections of Dielectric or Plasma Coated Conducting Spheres and Circular Cylinders," W. G. Swarner and L. Peters, Jr., AP-11, 558-69 (Sep 63). (SA-64-8937; I-A63-25313)

<u>IEEE TRANSACTIONS ON ANTENNAS AND PROPAGATION</u> (CONT.)

7357J "Scattering by a Narrow Perfectly Conducting Infinite Strip in a Gyroelectric Medium," S. R. Seshadri, AP-11, 570-73 (Sep 63). (SA-64-8938; I-A63-25314)

7358J "Theory of Absorbers in Scattering," V. H. Weston, AP-11, 578-84 (Sep 63). (SA-64-8939; I-A63-25315)

7359J "Electromagnetic Scattering by Antennas," R. F. Harrington, AP-11, 595 (Sep 63). (SB-64-4799)

7360J "Signals, Scatterers, and Statistics," V. Twersky, AP-11, 668-80 (Nov 63). [Correction: ibid., AP-12, 363 (May 64)]. (SA-64-5815; I-A64-11807)

7361J "A Modified Geometrical Optics Method for Scattering by Dielectric Bodies," R. G. Kouyoumjian, L. Peters, Jr., and D. T. Thomas, AP-11, 690-703 (Nov 63). (SA-64-5816; I-A64-11809)

7362J "The Optical Model of Scattering by a Composite Cylinder," R. D. Kodis and T. T. Wu, AP-11, 703-05 (Nov 63). (SA-64-5817; I-A64-11810)

7363J "New Techniques for Modifying Monostatic and Multistatic Radar Cross-Sections," L. Weinberg, AP-11, 717-19 (Nov 63). (SB-64-6588; I-A64-11820)

7364J "On the Radar Cross Section of a Coated Plate," C. M. Knop and G. I. Cohn, AP-11, 719-21 (Nov 63). [Corrections: ibid., AP-12, 242 and 516 (1964)]. (SB-64-6542; I-A64-11821)

7365J "The Fluctuation of Radar Ground Return Due to Antenna Scanning," J. P. Ruina, AP-11, 722-23 (Nov 63). (SB-64-6525; I-A64-11822)

7366J "On the Scattering of Electromagnetic Waves by a Moving Tropospheric Layer Having Sinusoidal Boundaries," D. T. Gjessing and F. Irgens, AP-12, 51-64 (Jan 64). (SB-64-6556; I-A64-14636)

7367J "An Experimental Study of the Variation of the Tropospheric Scattering Cross Section and Air Velocity with Position in Space," D. T. Gjessing, AP-12, 65-73 (Jan 64). (SB-64-6557; I-A64-14637)

7368J "Electromagnetic Scattering from a Spherical Nonuniform Medium--Part I: General Theory," D. Arnush, AP-12, 86-90 (Jan 64). (SA-64-14892; I-A64-14640)

7369J "Electromagnetic Scattering from a Spherical Nonuniform Medium--Part II: The Radar Cross Section of a Flare," R. S. Margulies and F. L. Scarf, AP-12, 91-96 (Jan 64). (SA-64-14893; I-A64-14641)

7370J "The Echo Area of Small Rectangular Plates with Linear Slots," R. B. Green, AP-12, 101-04 (Jan 64). (SB-64-6084; I-A64-14643)

7371J "High-Frequency Scattering by Multiple Spheres," D. J. Angelakos and N. Kumagai, AP-12, 105-09 (Jan 64). (SA-64-14894; I-A64-14644)

7372J "Some Bounds to the Behaviour of Small Resonant Scatterers," R. F. Harrington, AP-12, 126 (Jan 64). (SA-64-16659)

7373J "Radio Reflections from Meteor Trails," R. N. Franklin, AP-12, 132 (Jan 64). (SA-64-20938)

7374J "Retrodirective Array Using the Heterodyne Technique," C. Y. Pon, AP-12, 176-80 (Mar 64).

7375J "An Active Retrodirective Array for Satellite Communication," S. N. Andre and D. J. Leonard, AP-12, 181-86 (Mar 64).

7376J "Spherical Retrodirective Array," E. M. Rutz-Philipp, AP-12, 187-94 (Mar 64).

IEEE TRANSACTIONS ON ANTENNAS AND PROPAGATION (CONT.)

7377J "The Radar Cross Section of Polyfoam Towers," W. E. Blore, AP-12, 237-38 (Mar 64). (SB-64-9086; I-A64-16617)

7378J "Scattering of Electromagnetic Waves from Dielectric Coated Conducting Spheres," J. Rheinstein, AP-12, 334-40 (May 64). (SA-64-24845; I-A64-19857)

7379J "Scattering of Electromagnetic Waves by an Anisotropic Plasma-Coated Conducting Cylinder," H. C. Chen and D. K. Cheng, AP-12, 348-53 (May 64). (SA-64-24847; I-A64-19859)

7380J "Prediction and Measurement of the Coherent and Incoherent Power Reflected from a Rough Surface," R. H. Clarke and G. O. Hendry, AP-12, 353-64 (May 64). (SA-64-24833; I-A64-19860)

7381J "The Scattering of Electromagnetic Waves by Conductors of Linear Extent Comparable with the Wavelength," W. H. Watson, AP-12, 374-75 (May 64). (SB-64-12349; I-A64-19869)

7382J "Radar Cross Section of a Corrugated Metallic Pipe," W. R. Bradford, AP-12, 507-08 (Jul 64). (SB-65-1360)

7383J "A Multi-Layer Microwave Absorber," A. R. Jones and E. R. Wooding, AP-12, 508-09 (Jul 64). (SB-64-15377)

7384J "The Minimization of the Back Scattering of a Cylinder by Central Loading," K. M. Chen and V. Liepa, AP-12, 576-82 (Sep 64). (SB-64-15275)

7385J "The Radar Cross Section of Ogives, Double-Rounded Cones, Double-Backed Cones, and Cone Spheres," W. E. Blore, AP-12, 583-90 (Sep 64). (SB-64-15987)

7386J "Toward a Simple Mathematical Model for Microwave Backscatter from the Sea Surface at Near-Vertical Incidence," J. K. Parks, AP-12, 590-605 (Sep 64). (SA-64-30054)

7387J "Scattering of Radio Waves by a Moving Atmospheric Rippled Layer - A Simple Model-Experiment," D. T. Gjessing and F. Irgens, AP-12, 703-09 (Nov 64). (SB-65-4919; I-A65-11736)

7388J "Scattering from Parallel Metallic Cylinders with Arbitrary Cross Sections," M. G. Andreasen, AP-12, 746-54 (Nov 64). (SB-65-4210; I-A65-11740)

7389J "Scattering from Plane Layered Media," G. Franceschetti, AP-12, 754-63 (Nov 64). (SB-65-4211)

7390J "A New Approach to the Diffraction of a Surface Wave by a Semi-Infinite Grounded Dielectric Slab," W. R. Jones, AP-12, 767-77 (Nov 64). (SB-65-4213)

7391J "Note on the Scattering of Waves by Rough Surfaces," R. Ruffine, AP-12, 802-03 (Nov 64). (SB-65-8644; I-A65-11748)

IEEE TRANSACTIONS ON BROADCASTING

7392J "Height Gain Measurements at V.H.F. and U.H.F. Behind a Grove of Trees," A. H. LaGrone, P. E. Martin, and C. W. Chapman, BC-9, 37-54 (Feb 63). (SB-63-6416)

IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES

7393J "Field Measurements Using Active Scatterers," R. F. Harrington, MTT-11, 454-55 (Sep 63). (SB-64-10653)

IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES (CONT.)

7394J "A Vacuum Forming Technique for the Fabrication of Spherical or Prolate Spheroidal Reflectors," J. E. Degenford and M. D. Sirkis, MTT-11, 553 (Nov 63). (I-A64-13059)

7395J "Wave Propagation in Sinusoidally Stratified Dielectric Media," T. Tamir, H. C. Wang, and A. A. Oliner, MTT-12, 323-35 (May 64). (SB-64-11074)

7396J "Back-Scattering Measurements of a Slowly Moving Target," O. P. McDuff, H. Mott, and C. S. Durrett, Jr., MTT-12, 541-46 (Sep 64). (SA-65-4959; I-A64-27375)

IEEE TRANSACTIONS ON MILITARY ELECTRONICS

7397J "Radar Investigations of the Planets," R. M. Goldstein, MIL-8, 199-206 (Jul-Oct 64). [Also appeared in IEEE Trans. Ant. Prop., AP-12, 865-72 (Dec 64)]. (SB-65-4995; I-A64-28195; I-A65-15083)

7398J "Radar Backscatter from the Earth's Ionosphere," W. E. Gordon, MIL-8, 206-10 (Jul-Oct 64). [Also appeared in IEEE Trans. Ant. Prop., AP-12, 872-76 (Dec 64)]. (SB-65-4983; I-A64-28196; I-A65-15084)

7399J "Radar Echoes from the Sun," J. C. James, MIL-8, 210-25 (Jul-Oct 64). [Also appeared in IEEE Trans. Ant. Prop., AP-12, 876-91 (Dec 64)]. (SA-65-7655; I-A64-28197; I-A65-15085)

7400J "Radio and Radar Astronomy and the Exploration of the Universe," J. D. Kraus, MIL-8, 232-35 (Jul-Oct 64). [Also appeared in IEEE Trans. Ant. Prop., AP-12, 898-901 (Dec 64)]. (SB-65-4998; I-A65-15087)

IEEE TRANSACTIONS ON NUCLEAR SCIENCE

7401J "The Propagation of an Electromagnetic Wave Through a Diffusing Plasma," W. H. Schoendorf and F. V. Schultz, NS-11, 23-33 (Jan 64). (SA-64-14659)

INDIAN JOURNAL OF METEOROLOGY AND GEOPHYSICS

7402J "A Preliminary Study of 'Angel' Activity Near Bombay," D. B. Rai, 10, No. 3, 313-20 (Jul 59). (SB-60-6443; MG-60-11H-124)

7403J "Reflection of Micro-Waves from Earth's Surface," A. C. De, 11, No. 1, 45-49 (Jan 60). (SB-60-6399)

7404J "A Turbulent Convection Theory of Radar Angels," D. B. Rai, 12, No. 3, 439-46 (Jul 61). (MG-62-13.8-518)

7405J "Very Fast Moving Radar Echoes as Observed on CPS-9 Radar," S. M. Kulshrestha and B. L. Sharma, 12, No. 4, 629-36 (Oct 61). (MG-62-13.11-505)

7406J "Eddy Structure of Updraft in a Cumulus Cloud and Observed Depth of First Radar Echo," R. C. Srivastava, 13, Special No., 109-16 (Mar 62). (SB-63-7800)

7407J "Freezing Rain at Delhi and Associated Melting Band Characteristics," K. R. Biswas, B. V. Ramana Murty, and A. K. Roy, 13, Special No., 137-42 (Mar 62). (SB-63-7802)

7408J "Bright Band Phenomenon Over Calcutta and Neighbourhood," A. C. De, 13, Special No., 143-46 (Mar 62). (SB-63-7803)

7409J "Hot Weather Angels Associated with High Level Temperature Inversions," S. M. Kulshrestha, 13, No. 2, 218-26 (Apr 62). (SA-63-1452)

INDIAN JOURNAL OF PHYSICS AND PROCEEDINGS OF THE INDIAN ASSOCIATION FOR THE CULTIVATION OF SCIENCE

7410J "Microwave Analogue for X-Ray Diffraction. I. Effect of the Crystallite Size," G. B. Mitra and G. S. Sanyal, 34, No. 3, 103-06 (Mar 60). (SA-61-9129)

7411J "Microwave Analogue for X-Ray Diffraction. II. Size of the Scatterers," G. S. Sanyal and G. B. Mitra, 35, No. 7, 325-32 (Jul 61). (SA-61-19031)

7412J "Reflection and Transmission Properties of a Stratified Plasma," J. Basu, 38, No. 9, 435-52 (Sep 64). (SA-65-8974)

INDIAN JOURNAL OF PURE AND APPLIED PHYSICS

7413J "Scattering of Radio Waves from the F Region of the Ionosphere," R. K. Rai, 2, 234-35 (Jul 64). (SB-64-14285; I-A64-27040)

7414J "Shape of the Periodic Fading Curve of Radio Waves Reflected from the Ionosphere," D. Jha, 2, 362-64 (Nov 64). (I-A65-18189)

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCE (GB)

7415J "Diffraction by a Right-Angled Dielectric Wedge," J. Radlow, 2, 275-90 (Jun 64). (SA-64-27646)

7416J "The Transient Behavior of Diffraction of Plane Pulse by a Circular Cylinder," Y. M. Chen, 2, 417-29 (Oct 64). (SB-65-4217)

IRE TRANSACTIONS ON AEROSPACE AND NAVIGATIONAL ELECTRONICS

7417J "Effect of Precipitation on the Design of Radio Altimeters," R. K. Moore, ANE-4, 24-29 (Mar 57). (SB-57-6142; ET-58-2099)

7418J "An Analysis of Bistatic Radar," M. I. Skolnik, ANE-8, 19-27 (Mar 61). (SB-61-4816; I-61-4238)

IRE TRANSACTIONS ON ANTENNAS AND PROPAGATION

7419J "Optical Fresnel Zone Gain of a Rectangular Aperture," C. Polk, AP-4, 65-69 (Jan 56).

7420J "Diffraction of Electromagnetic Waves Caused by Apertures in Absorbing Plane Screens," H. E. J. Neugebauer, AP-4, 115-19 (Apr 56). (SB-58-1350)

7421J "Multiple Scattering by Randomly Distributed Obstacles: Methods of Solution," C. M. Chu and S. W. Churchill, AP-4, 142-48 (Apr 56).

7422J "Diffraction of Plane Electromagnetic Waves by a Rectangular Aperture," M. Suzuki, AP-4, 149-56 (Apr 56). (SB-58-1997)

7423J "The Interpretation of Numerical Results Obtained by Rigorous Diffraction Theory for Cylinders and Spheres," H. C. Van de Hulst, AP-4, 195-202 (Jul 56).

7424J "The Theoretical and Numerical Determination of the Radar Cross Section of a Prolate Spheroid," K. M. Siegel, F. V. Schultz, B. H. Gere, and F. B. Sleator, AP-4, 266-75 (Jul 56).

7425J "A Critique of the Variation Method in Scattering Problems," D. S. Jones, AP-4, 297-301 (Jul 56).

7426J "Diffraction by a Convex Cylinder," J. B. Keller, AP-4, 312-21 (Jul 56).

7427J "Transmission Characteristics of Inclined Wire Gratings," O. J. Snow, AP-4, 650-54 (Oct 56). (ET-58-3773)

IRE TRANSACTIONS ON ANTENNAS AND PROPAGATION (CONT.)

7428J "On Scattering and Reflection of Electromagnetic Waves by Rough Surfaces," V. Twersky, AP-5, 81-90 (Jan 57). (SB-57-5894; ET-58-3775)

7429J "Diffraction of Surface Waves by a Semi-Infinite Dielectric Slab," C. M. Angulo, AP-5, 100-09 (Jan 57). (SB-57-6216)

7430J "Plane-Wave Scattering by Small-Angle Cones," L. B. Felsen, AP-5, 121-29 (Jan 57). (SB-57-6380)

7431J "Universal Curves for the Vertical-Polarization Reflection Coefficient," G. P. Ohman, AP-5, 140-42 (Jan 57). (ET-58-3951)

7432J "Scattering from Finite Cones," K. M. Siegel, AP-5, 155 (1957).

7433J "Some Electromagnetic Transmission and Reflection Properties of a Strip Grating," R. I. Primich, AP-5, 176-82 (Apr 57). (SB-57-6189)

7434J "The Dependence of Microwave Radio Signal Spectra on Ocean Roughness and Wave Spectra," C. I. Beard and I. Katz, AP-5, 183-91 (Apr 57). (SB-58-415)

7435J "Back-Scattering Cross Section of a Thin, Dielectric Spherical Shell," M. G. Andreasen, AP-5, 267-70 (Jul 57). (SB-58-1352)

7436J "The Role of Fock Functions in the Theory of Diffraction by Convex Surfaces," N. A. Logan, AP-5, 328 (1957). [Abstract only]

7437J "Absorption of Plane Waves in an Optimum Nonuniform Medium Backed by a Metallic Surface," I. Jacobs, AP-5, 332 (1957). [Abstract only]

7438J "Some Observations on Scattering by Turbulent Inhomogeneities," M. Balser, AP-5, 383-90 (Oct 57). (SB-58-1630; ET-59-1335)

7439J "Asymptotic Expansion of the Diffracted Wave for a Semi-Infinite Cone," L. B. Felsen, AP-5, 402-04 (1957).

7440J "An Analytical Study of Scattering by Thin Dielectric Rings," L. L. Philipson, AP-6, 3-8 (Jan 58). (SB-58-2541; ET-59-1517)

7441J "Scattering of Electromagnetic Waves in Beyond-the-Horizon Radio Transmission," D. I. Paul, AP-6, 61-65 (Jan 58). (SB-58-2725)

7442J "Radio Echoes from Auroral Ionization Detected at Relatively Low Geomagnetic Latitudes," R. L. Leadabrand and A. M. Peterson, AP-6, 65-79 (Jan 58). (SB-58-2727; ET-59-1670)

7443J "A Statistical Model for Forward Scattering of Waves Off a Rough Surface," L. M. Spetner, AP-6, 88-94 (Jan 58). (SB-58-2543; ET-59-1518)

7444J "End-Fire Echo Area of Long, Thin Bodies," L. Peters, Jr., AP-6, 133-39 (Jan 58). (SB-58-2702; ET-59-1446)

7445J "Back-Scattering Cross-Section of a Center-Loaded Cylindrical Antenna," Yueh-Ying Hu, AP-6, 140-48 (Jan 58). (SB-58-2703; ET-59-1444)

7446J "Electromagnetic Diffraction by Dielectric Strips," D. C. Stickler, AP-6, 148-51 (Jan 58). [Corrections: ibid., AP-6, 320 (Jul 58)]. (SB-58-2544; ET-59-1516)

7447J "Phantom Radar Targets at Millimeter Radio Wavelengths," C. W. Tolbert, A. W. Straiton, and C. O. Britt, AP-6, 380-84 (Oct 58). (SB-59-1210; ET-59-3315)

7448J "Back-Scattering Measurements with a Space-Separation Method," H. J. Schmitt, AP-7, 15-22 (Jan 59). (SB-59-5559; ET-59-3843)

IRE TRANSACTIONS ON ANTENNAS AND PROPAGATION (CONT.)

7449J "Preliminary Results of 400 Mc Radar Investigations of Auroral Echoes at College, Alaska," R. L. Leadabrand, L. Dolphin, and A. M. Peterson, AP-7, 127-36 (Apr 59). (SB-59-4921; ET-59-4065)

7450J "The Inverse Scattering Problem in Geometrical Optics and the Design of Reflectors," J. B. Keller, AP-7, 146-49 (Apr 59). (SB-59-5254)

7451J "On Scattering by Large Conducting Bodies," R. F. Harrington, AP-7, 150-53 (Apr 59). (SB-59-5255; ET-59-4029)

7452J "Effect of Surface Reflections on Rain Cancellation of Circularly Polarized Radars," R. McFee and T. M. Maher, AP-7, 199-201 (Apr 59). (SB-59-6120; ET-59-4072)

7453J "Microwave Scattering by Turbulent Air," C. E. Phillips, AP-7, 245-51 (Jul 59). (SB-60-997; ET-60-641)

7454J "Geometrical-Optics Approximation of Near-Field Back-Scattering," F. S. Holt, AP-7, 434-35 (Oct 59). (SB-60-4491; ET-60-2022)

7455J "Infinite Integral Transforms in Diffraction Theory," P. C. Clemmow, AP-7, S7-S11 (Dec 59).

7456J "Diffraction of Scalar Waves by a Circular Aperture," J. Bazer and A. Brown, AP-7, S12-S20 (Dec 59). [Comments: A. E. Heins, ibid., AP-8, 633 (Sep 60)].

7457J "Scalar Diffraction by an Elliptic Cylinder," N. D. Kazarinoff and R. K. Ritt, AP-7, S21-S27 (Dec 59).

7458J "Fock Theory--An Appraisal and Exposition," R. F. Goodrich, AP-7, S28-S36 (Dec 59).

7459J "Reduction of the Integral Equations for High-Frequency Diffraction by Disks and Strips," B. Noble, AP-7, S37-S42 (Dec 59).

7460J "Pulse Return from a Sphere," V. H. Weston, AP-7, S43-S51 (Dec 59).

7461J "Decay Exponents and Diffraction Coefficients for Surface Waves on Surfaces of Nonconstant Curvature," J. B. Keller and B. R. Levy, AP-7, S52-S61 (Dec 59).

7462J "New Results in Backscattering from Cones and Spheroids," A. Olte and S. Silver, AP-7, S61-S67 (Dec 59).

7463J "Diffraction by Surfaces of Variable Curvature," W. Franz and K. Klante, AP-7, S68-S70 (Dec 59).

7464J "Diffraction of an Electromagnetic Plane Wave by a Funnel-Shaped Screen," W. Braunbek, AP-7, S71-S77 (Dec 59).

7465J "The Diffraction and Refraction of Plane Pulses," V. M. Papadopoulos, AP-7, S78-S87 (Dec 59).

7466J "Diffraction by a Half-Plane with a Special Impedance Variation," J. Shmoys, AP-7, S88-S90 (Dec 59).

7467J "Some New Forms of Huygens' Principle," V. H. Rumsey, AP-7, S103-S116 (Dec 59).

7468J "Fields in the Neighborhood of a Caustic," I. Kay, AP-7, S255-S260 (Dec 59).

7469J "Diffraction of Nearly Plane 3.2-cm EM Waves by 45° and 90° Conducting Wedges. Comparison with Theory," N. E. Hedgecock and A. B. McLay, AP-7, S284-S287 (Dec 59).

IRE TRANSACTIONS ON ANTENNAS AND PROPAGATION (CONT.)

7470J "On the Propagation of Electromagnetic Waves Through Anisotropic Layers," G. Tyras and G. Held, AP-7, S296-S300 (Dec 59).

7471J "Scattering by Quasi-Periodic and Quasi-Random Distributions," V. Twersky, AP-7, S307-S319 (Dec 59).

7472J "Modified W.K.B. Methods for the Propagation and Scattering of Electromagnetic Waves," D. S. Saxon, AP-7, S320-S323 (Dec 59).

7473J "Interaction of Electromagnetic Waves with Some Natural Surfaces," W. H. Peake, AP-7, S324-S329 (Dec 59).

7474J "Electromagnetic Scattering by High-Density Meteor Trails," H. Brysk, AP-7, S330-S336 (Dec 59).

7475J "A New Method of Near Field Analysis," R. C. Hansen and L. L. Bailen, AP-7, S458-S467 (Dec 59).

7476J "Back-Scattering Cross-Sections of Cylindrical Wires of Finite Conductivity," E. S. Cassedy and J. Fainberg, AP-8, 1-7 (Jan 60). (SB-60-6710; ET-60-3370)

7477J "A Multipurpose Radar Target," J. W. Carr, AP-8, 7-10 (Jan 60). (SB-60-6428).

7478J "High-Frequency Diffraction of Electromagnetic Waves by a Circular Aperture in an Infinite Plane Conducting Screen," S. R. Seshadri and T. T. Wu, AP-8, 27-36 (Jan 60). (SB-60-6711; ET-60-3456)

7479J "High-Frequency Diffraction of Plane Waves by an Infinite Slit for Grazing Incidence," S. R. Seshadri and T. T. Wu, AP-8, 37-42 (Jan 60). (SB-60-6712; ET-60-3455)

7480J "Experimental Studies of Meteor Echoes at 200 Mc," J. L. Heritage, S. Weisbrod, and W. J. Fay, AP-8, 57-61 (Jan 60). (SB-60-6392)

7481J "Scattering by an Infinite Array of Thin Dielectric Sheets," R. E. Collin, AP-8, 62-67 (Jan 60). (SB-60-6713; ET-60-3380)

7482J "Reciprocity and Scattering by Certain Rough Surfaces," W. S. Ament, AP-8, 167-74 (Mar 60). (SA-60-17107; ET-60-4194)

7483J "Backscattering from a Finite Cone," J. B. Keller, AP-8, 175-82 (Mar 60). (SA-60-17106; ET-60-4195)

7484J "Aircraft Scintillation Spectra," R. B. Muchmore, AP-8, 201-12 (Mar 60). (SB-60-6965; ET-60-4260)

7485J "Two Statistical Models for Radar Terrain Return," L. M. Spetner and I. Katz, AP-8, 242-46 (May 60). (SB-60-6968; ET-61-1179)

7486J "Radar Terrain Return Measured at Near-Vertical Incidence," A. R. Edison, R. K. Moore, and B. D. Warner, AP-8, 246-54 (May 60). (SB-60-6966; ET-61-1180)

7487J "Relation Between a Class of Two-Dimensional and Three-Dimensional Diffraction Problems," L. B. Felsen and S. N. Karp, AP-8, 407-14 (Jul 60). (SB-61-624)

7488J "Solution of a Reflection Problem by Means of a Transmission Line Analogy," B. L. Jones and P. C. Patton, AP-8, 418-22 (Jul 60). (SB-61-635)

7489J "Van Atta Reflector Array," E. D. Sharp and M. A. Diab, AP-8, 436-38 (Jul 60).

7490J "An Experimental Investigation of the Fock Approximation for Conducting Cylinders," L. Wetzel and D. B. Brick, AP-8, 599-602 (Nov 60). (SB-61-1339)

7491J "Reflection Factor of Gradual-Transition Absorbers for Electromagnetic and Acoustic Waves," K. Walther, AP-8, 608-21 (Nov 60). (SB-61-1336)

IRE TRANSACTIONS ON ANTENNAS AND PROPAGATION (CONT.)

7492J "Concerning the Assumption of Random Distribution of Scatterers as a Model of an Aircraft for Tracking Radars," L. Peters, Jr., and F. C. Weimer; R. B. Muchmore, AP-9, 110-11; 112-13 (Jan 61). [Comments: ibid., AP-9, 227-29 (Mar 61)]. (SB-61-4283; I-61-3267)

7493J "Diffraction of a Plane Wave by an Infinite Slit in a Unidirectionally Conducting Screen," S. R. Seshadri, AP-9, 199-207 (Mar 61). (SB-61-3133)

7494J "Scatter Communications with Radar Chaff," R. A. Hessemer, Jr., AP-9, 211-17 (Mar 61). [Comments: E. S. Cassedy and J. Fainberg; R. A. Hessemer, Jr., ibid., AP-9, 497; 497-98 (Sep 61)]. (SB-61-3478; SA-63-5376)

7495J "Diffraction by a Slit," R. Plonsey, AP-9, 217-19 (Mar 61). (SB-61-3135)

7496J "A Scattering Measurement Technique," K. Steinbach and F. B. Varnum, AP-9, 312-13 (May 61). (SB-62-4077)

7497J "Current Distributions on Cylinders Excited by Spherical Electromagnetic Waves," D. B. Brick, AP-9, 315-17 (May 61). (SB-61-6185)

7498J "Reflection of Electromagnetic Waves from a Stratified Inhomogeneity," R. Yamada, AP-9, 364-70 (Jul 61). (SB-62-2188; I-61-7232)

7499J "Back-Scattering from a Finite Cone--Comparison of Theory and Experiment," J. B. Keller, AP-9, 411-12 (Jul 61). (SB-62-916)

7500J "Coherent and Incoherent Scattering of Microwaves from the Ocean," C. I. Beard, AP-9, 470-83 (Sep 61). (SB-62-1198)

7501J "Electromagnetic Propagation in an Exponential Ionization Density," L. S. Taylor, AP-9, 483-87 (Sep 61). (I-61-10277)

7502J "Scattering by a Periodically Apertured Conducting Screen," R. B. Kieburtz and A. Ishimaru, AP-9, 506-14 (Nov 61). (SB-62-5299)

7503J "Diffraction of a Plane Wave by a Perfectly Conducting Sphere with a Concentric Shell," M. A. Plonus, AP-9, 573-76 (Nov 61). [Comments: R. J. Garbacz and M. A. Plonus, ibid., AP-10, 345 (May 62)]. (SA-62-7751)

7504J "On the Mapping of Extended Sources with Nonlinear Correlation Antennas," C. J. Drane and G. B. Parrent, AP-10, 126-30 (Mar 62).

7505J "The Reflection of Microwaves by a Refractive Layer Perturbed by Waves," E. E. Gossard, AP-10, 317-25 (May 62). (SB-62-11311)

7506J "A Selective Survey of Soviet Bloc Scatter Development," J. H. Barton, AP-10, 335-40 (May 62). (SB-62-11321; I-62-7813)

7507J "Scattering Pattern of a Plane Wave from a Magneto-Plasma Cylinder," S. Adachi, AP-10, 352 (May 62). (SB-62-12430)

7508J "Properties of Focused Apertures in the Fresnel Region," J. W. Sherman, AP-10, 399-408 (Jul 62).

7509J "Universal Curves for the Horizontal Polarization Reflection Coefficient," G. P. Ohman, AP-10, 450-52 (Jul 62). (SB-62-13486; I-62-8909)

7510J "The W.K.B. Solution for Transmission Through Inhomogeneous Plane Layers," J. H. Richmond, AP-10, 472-73 (Jul 62). (SB-64-15034)

7511J "Two-Dimensional Diffraction in Homogeneous Anisotropic Media," S. N. Samaddar, AP-10, 621-24 (Sep 62). (SB-63-579)

IRE TRANSACTIONS ON ANTENNAS AND PROPAGATION (CONT.)

7512J "A Failure of Creeping-Wave Theory," N. D. Kazarinoff and T. B. A. Senior, AP-10, 634-38 (Sep 62). (SB-63-581)

7513J "Luneberg-Kline Analysis of Scattering from a Sinusoidal Dielectric Interface," A. D. Jacobson, AP-10, 715-21 (Nov 62). (SA-63-7704)

7514J "Statistics of Phase Quadrature Components of Microwave Fields Transmitted Through a Random Medium," C. I. Beard, AP-10, 721-31 (Nov 62). (SA-63-7694)

7515J "On Scattering of Waves by the Infinite Grating of Circular Cylinders," V. Twersky, AP-10, 737-65 (Nov 62). (SA-63-7705)

7516J "Multiple Scattering and Wave Propagation in Periodic Structures," J. L. Yen, AP-10, 769-75 (Nov 62). (SA-63-7697)

7517J "The Effect of a Discontinuity in Curvature in High-Frequency Scattering," V. H. Weston, AP-10, 775-80 (Nov 62). (SA-63-7706)

7518J "A Proposed High Gain Wide Angle Coverage, Passive, Modulated Re-Radiator," R. G. Wanselow, AP-10, 785 (Nov 62). (SB-63-5358)

IRE TRANSACTIONS ON ELECTRON DEVICES

7519J "Proposed Method for Controlling and Minimizing Reflections from a Surface," R. H. Mattson, ED-8, 386-89 (Sep 61). (SB-62-4078)

IRE TRANSACTIONS ON INFORMATION THEORY

7520J "A Statistical Theory of Target Detection by Pulsed Radar," J. I. Marcum, IT-6, 59-144; Appendix, 145-267 (Apr 60). (SB-61-422)

7521J "Probability of Detection for Fluctuating Targets," P. Swerling, IT-6, 269-308 (Apr 60). (SB-60-8302)

IRE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES

7522J "Electromagnetic Backscattering Measurements by a Time-Separation Method," C. C. H. Tang, MTT-7, 209-13 (Apr 59). (SB-59-5583; ET-60-175)

7523J "The Dependence of Reflection on Incidence Angle," R. Redheffer, MTT-7, 423-29 (Oct 59). (SA-60-5408)

7524J "Scattering of a Plane Wave on a Ferrite Cylinder at Normal Incidence," W. H. Eggimann, MTT-8, 440-45 (Jul 60). (SB-61-628)

7525J "Higher-Order Evaluation of Dipole Moments of a Small Circular Disk," W. H. Eggimann, MTT-8, 573 (Sep 60). (SA-61-7149)

7526J "Higher-Order Evaluation of Electromagnetic Diffraction by Circular Disks," W. H. Eggimann, MTT-9, 408-18 (Sep 61). (SB-62-2633)

7527J "A Survey of the Theory of Wire Grids," T. Larsen, MTT-10, 191-201 (May 62). (SA-62-17959)

7528J "Excitation of Surface Waves on a Unidirectionally Conducting Screen," S. R. Seshadri, MTT-10, 279-86 (Jul 62). (I-62-9860)

7529J "Electromagnetic Diffraction by a Planar Array of Circular Disks," W. H. Eggimann and R. E. Collin, MTT-10, 528-35 (Nov 62). (SB-63-3908)

IRE TRANSACTIONS ON SPACE ELECTRONICS AND TELEMETRY

7530J "Luneberg Lenses for Space Communications," R. C. Rudduck and C. H. Walter, SET-8, 31-38 (Mar 62). (SA-62-13695; I-62-6782)

IRE TRANSACTIONS ON SPACE ELECTRONICS AND TELEMETRY (CONT.)

7531J "The 1961 JPL Venus Radar Experiments," W. K. Victor and R. Stevens, SET-8, 84-97 (Jun 62). (I-62-9156)

IZVESTIYA AKADEMII NAUK SSSR, SERIYA GEOFIZICHESKAYA (USSR) [Cover-to-Cover Translation]

7532J "Radar Reflections from Auroras," V. I. Pogorelov, No. 8, 1048-51 (1958). (SA-60-798; MG-60-11H-121)

7533J "The Diffraction of Electromagnetic Waves by a Circular Cylinder in a Homogeneous Half-Space," B. P. D'yakonov, No. 9, 1332-43 (Sep 59). (ET-61-122)

7534J "Comparison Between Radio-Reflection Parameters and Variations of the Magnetic Field During Auroras," V. I. Pogorelov, No. 7, 1082-85 (Jul 60). (MG-62-13.7-201)

7535J "On a Theory of the Scattering of Electromagnetic Waves on the Surface of the Sea," V. I. Mikhaylov, No. 8, 1229-33 (1960). (TT-61/1-61-11523)

7536J "Diffraction of Electromagnetic Waves at a Conducting Plate in a Conducting Medium," V. I. Dmitriev, No. 6, 731-35 (1962). (SA-63-2125)

7537J "The Scattering of a Plane Electromagnetic Wave by Two Spheres," O. A. Germogenova, No. 4, 648-53 (1963). (SA-64-710; I-63-23184; I-A63-24148)

7538J "Radiation Reflected from the Surface of the Open Sea," G. M. Degtiarev, A. A. Sorokin, and Iu. A. Men'shov, 1578-83 (Oct 64). (I-A65-18822)

IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY. RADIOFIZIKA (USSR) [Cover-to-Cover Translation]

7539J "Contribution to the Theory of Motion of Ionospheric Inhomogeneities and Concerning the Problem of the Reflection of Electromagnetic Waves from the Inhomogeneities of the Epstein-Layer Type," V. P. Dokuchayev and V. I. Ivanchikov, 1, No. 1, 34-40, 150-52 (1958). [Trans: LC or SLA 59-19488]. (TT-60/1-59-19488)

7540J "On the Distribution of Scattering Elements During the Propagation of Radio Waves Over a Rough Sea Surface," S. Ya. Braude, 1, No. 3, 25-29 (1958). [Trans: LC or SLA 59-20695; OTS 59-13545]. (TT-59/2-59-13545; TT-60/1-59-20695)

7541J "On the Possibility of Determining the Function of Distribution of Scattering Elements on a Rough Sea Surface by Radar Methods," S. Ya. Braude and F. G. Bass, 1, No. 3, 161-62 (1958). [Trans: LC or SLA 59-20689; OTS 59-13547]. (TT-59/2-59-13547; TT-60/1-59-20689)

7542J "Diffraction of Electromagnetic Waves on a Semi-Infinite Grating," A. E. Bezmenov, 1, No. 3, 271-87 (1958). [Trans: LC or SLA 59-16561]. (TT-59/2-59-16561)

7543J "Certain Questions of the Theory of Wave Propagation in Media with Random Inhomogeneities (Survey)," N. G. Denisov and V. A. Zverev, 2, No. 4, 521 (1959). [Trans: OTS 62-11560; AD 244 801]. (TT-62/2-62-11560)

7544J "On the Influence of the Reflection Region on Radiowave Scattering in the Ionosphere," N. G. Denisov, 3, No. 2, 208-15 (1960). [Trans: OTS 62-11183; AD 244 803]. (TT-62/2-62-11183)

7545J "Electromagnetic Wave Diffraction in a Gyrotropic Layer Containing Random Inhomogeneities," N. G. Denisov, 3, No. 3, 393-404 (1960). [Trans: LC or SLA 60-27006]. (I-A63-10401; TT-61/1-60-27006)

IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY. RADIOFIZIKA (USSR) (CONT.)

7546J "On a Method of Measuring the Reflection Coefficient from the Earth and Inversion Layers," A. I. Sazonov, 3, No. 4, 517-18 (1960). [Trans: MDF S-176]. (TT-61/1-MDF S-176)

7547J "On the Theory of Combination Scattering of Waves on a Rough Surface," F. G. Bass, 4, No. 1, 58-66 (1961). [Trans: OTS 62-11571; AD 262 417]. (TT-62/2-62-11571)

7548J "Dielectric Stratified Coatings with Large Reflection Coefficient," A. A. Vorob'ev, L. N. Bezmaternykh, A. N. Didenko, et al., 7, No. 2, 338-42 (1964). (I-A64-21534)

7549J "Scattering of Waves in Conditions of Total Reflection," N. G. Denisov, 7, No. 2, 378-80 (1964). (I-A64-21537)

7550J "Scattering of Electromagnetic Waves by a Nonequilibrium Plasma," N. V. Sholokhov, 7, No. 3, 452-59 (1964). (I-A64-27357)

7551J "Diffraction of a Plane H-Polarized Electromagnetic Wave on an Array of Special Geometrical Configuration," L. N. Litvinenko, 7, No. 5, 887-97 (1964). (I-A65-15900)

7552J "Wave Transformation at the Interface Plasma-Dielectric," Ts. D. Loladze, 7, No. 5, 985-87 (1964). (I-A65-15907)

7553J "Electromagnetic Wave Diffraction at a Plane Metallic Array of Special Shape with a Dielectric and a Screen--The Case of Normal Incidence," L. N. Litvinenko, 7, No. 6, 1211-14 (1964). (I-A65-19694)

JOURNAL OF THE ACOUSTICAL SOCIETY OF AMERICA

7554J "Frequency Dependence of [Sound] Echoes from Bodies of Different Shapes," R. Hickling, 30, 137-39 (Feb 58). (SA-58-4811)

7555J "Geometrical Theory of Diffraction in Inhomogeneous Media," B. D. Seckler and J. B. Keller, 31, 192-205 (Feb 59). (ET-59-2538)

7556J "Asymptotic Theory of Diffraction in Inhomogeneous Media," B. D. Seckler and J. B. Keller, 31, 206-16 (Feb 59). (ET-59-2539)

7557J "Transient Diffraction of Scalar Waves by a Fixed Sphere," R. G. Barakat, 32, 61-66 (Jan 60). (SA-60-2208)

7558J "Electromagnetic Reflection from Sound Waves," H. J. Schmitt and T. T. Wu, 32, 1660-67 (Dec 60). (SA-61-369; ET-61-1387)

7559J "Theoretical Development of Volume Reverberation as a First-Order Scattering Phenomenon," H. R. Carleton, 33, 317-23 (Mar 61). (SA-61-5331)

7560J "Exact Solution of Wave Scattering by Irregular Surfaces," H. W. Marsh, 33, 330-34 (Mar 61). (SA-61-5332)

7561J "Experimental Study of the Scattering of Acoustic Energy from Solid Metal Spheres in Water," L. D. Hampton and C. M. McKinney, 33, 664-73 (May 61). (SA-61-6936)

7562J "Diffraction of Electromagnetic Waves by Sound Waves," H. J. Schmitt, 33, 1288-92 (Oct 61). (SA-61-16564; ET-62-800)

7563J "Model Experiments with Acoustic Van Atta Reflectors," K. Walther, 34, 665-74 (May 62). (SA-62-13410)

JOURNAL OF THE ACOUSTICAL SOCIETY OF AMERICA (CONT.)

7564J "Analysis of Rough Surfaces by Scattering," L. N. Liebermann, 35, 932 (Jun 63). (I-A63-19906)

7565J "Diffraction of Plane Waves by an Elliptic Cylinder," R. Barakat, 35, 1990-96 (Dec 63). (I-A64-13303)

7566J "Electromagnetic Reflection from Sound Waves. II.," H. J. Schmitt and T. T. Wu, 36, 437-45 (Mar 64). (SA-64-14887)

7567J "Doppler Shift of Sonar Backscatter from the Sea Surface," R. H. Mellen, 36, 1395-96 (Jul 64). (SB-64-12341)

7568J "Backscattering of Sound from the Sea Surface," M. Schulkin and R. Shaffer, 36, 1699-1703 (Sep 64). (SA-64-30924)

7569J "Wave Scattering and Transmission at Irregular Surfaces," E. Y. T. Kuo, 36, 2135-42 (Nov 64). (SA-65-2118)

JOURNAL OF AEROSPACE SCIENCES

7570J "On Trails of Axisymmetric Hypersonic Blunt Bodies Flying Through the Atmosphere," S. Feldman, 28, 433-48, 470 (Jun 61). (MG-62-13.4-74)

JOURNAL OF APPLIED METEOROLOGY

7571J "Cloud Layer Detection by WSR-57 Radar," J. H. Hand, 3, 58-64 (Feb 64). (I-A64-16323)

7572J "Evaluation of Precipitation Measurements with the WSR-57 Weather Radar," J. W. Wilson, 3, 164-74 (Apr 64). (I-A64-18018)

7573J "Dual-Frequency Radar Observations of Precipitation," G. B. Walker, L. S. Lamberth, and J. J. Stephens, 3, 430-38 (Aug 64). (I-A64-25880)

7574J "A Demonstration of Antenna Beam Errors in Radar Reflectivity Patterns," R. J. Donaldson, Jr., 3, 611-23 (Oct 64). (I-A65-12079)

JOURNAL OF APPLIED PHYSICS

7575J "Asymptotic Evaluation of the Field at a Caustic," I. Kay and J. B. Keller, 25, 876-83 (Jul 54).

7576J "Reflection of Plane-Polarized, Electromagnetic Radiation from an Echelette Diffraction Grating," W. C. Meecham and C. W. Peters, 28, 216-17 (Feb 57). (SA-57-5491)

7577J "Extension of Babinet's Principle to Absorbing and Transparent Materials, and Approximate Theory of Backscattering by Plane, Absorbing Disks," H. E. J. Neugebauer, 28, 302-07 (Mar 57). (SA-57-6365; ET-57-2725)

7578J "Diffraction by an Aperture," J. B. Keller, 28, 426-44 (Apr 57). (ET-57-3114)

7579J "Diffraction by an Aperture. Part 2," J. B. Keller, R. M. Lewis, and B. D. Seckler, 28, 570-79 (May 57). (ET-57-3115)

7580J "Back-Scattering from Dielectric-Coated Infinite Cylindrical Obstacles," C. C. H. Tang, 28, 628-33 (May 57). (SA-57-7243; ET-57-3117)

7581J "Concerning Lewis' Diffraction Pattern in the Plane of a Half Screen," C. L. Andrews, 28, 1070 (Sep 57). (SA-58-3270)

7582J "Some New Aspects of the Reflection of Electromagnetic Waves on a Rough Surface," M. A. Biot, 28, 1455-63 (Dec 57). [Correction: M. A. Biot, ibid., 29, 998 (Jun 58)]. (SA-58-7212; SA-58-7213; ET-58-1392; ET-58-3056)

JOURNAL OF APPLIED PHYSICS (CONT.)

7583J "Diffraction Patterns at the Plane of a Slit in a Reflecting Screen," R. K. Hadlock, 29, 918-20 (Jun 58). (SA-59-477; ET-58-3059)

7584J "Diffraction by a Perfectly Absorbing Thin Screen," C. C. Derwin, 29, 921-22 (Jun 58). (SA-59-478; ET-58-3060)

7585J "Diffraction by a Slit," R. Plonsey and H. P. Hsu, 30, 1468 (Sep 59). (SA-59-12149)

7586J "Diffraction by an Infinite Slit," H. Levine, 30, 1673-82 (Nov 59). (SA-60-1207)

7587J "Scattering by Non-Spherical Particles," J. M. Greenberg, 31, 82-84 (Jan 60).

7588J "Absorption and Reflection Spectrum of a Plasma," W. D. Hershberger, 31, 417-22 (Feb 60). (SA-60-5409)

7589J "On the Reflection of Electromagnetic Waves from a Medium Excited by Acoustic Waves," H. J. Schmitt and D. L. Sengupta, 31, 439-40 (Feb 60). (SA-60-7220)

7590J "Total Electromagnetic Cross-Sections of Imperfectly Conducting Cylinders," E. S. Cassedy and J. Fainberg, 31, 739-40 (Apr 60). (SA-60-12698; ET-60-2695)

7591J "Finite Amplitude Electromagnetic Waves in Gyromagnetic Media," B. A. Auld, Supplement to Vol. 31, 106S-107S (May 60). (SA-60-10190)

7592J "Scattering of Electromagnetic Waves from an Infinitely Long Magnetized Cylindrical Plasma," P. M. Platzman and H. T. Ozaki, 31, 1597-1601 (Sep 60). (SA-60-17018; ET-61-123)

7593J "Scattering of Radiation by a Plasma," F. I. Boley, 31, 1692 (Sep 60). (ET-61-124)

7594J "Aperture Fields in the Diffraction by a Slit," H. P. Hsu, 31, 1742-46 (Oct 60). (ET-61-508)

7595J "Theoretical and Experimental Study of the Back-Scattering Cross-Section of an Infinite Ribbon," M. S. Macrakis, 31, 2261-66 (Dec 60). (SA-61-1973; ET-61-1131)

7596J "Reflection and Transmission of Electromagnetic Waves at Electron Density Gradients," F. A. Albini and R. G. Jahn, 32, 75-82 (Jan 61). (SA-61-3057)

7597J "Microwave Analogue to the Scattering of Light by Nonspherical Particles," J. M. Greenberg, N. E. Pedersen, and J. C. Pedersen, 32, 233-42 (Feb 61). (ET-61-1803)

7598J "Shift of the Shadow Boundary and Scattering Cross-Section of an Opaque Object," S. I. Rubinow and J. B. Keller, 32, 814-20 (May 61).

7599J "Reflection of Electromagnetic Waves at Electron Density Ramps," L. S. Taylor, 32, 1796-97 (Sep 61). (SA-61-16331)

7600J "Scattering of a Plane Wave by an Infinite Inhomogeneous Dielectric Cylinder--an Application of the Born Approximation," F. A. Albini and E. R. Nagelberg, 33, 1706-13 (May 62). (SA-62-11794; ET-62-4001)

7601J "Diffraction of Spherical Scalar and Vector Waves at Axial Points of a Circular Aperture and Disk," K. L. McDonald, 33, 1944-49 (Jun 62). (SA-62-13691; ET-62-2966)

7602J "Mid-Field Forward Scattering," C. I. Beard, T. H. Kays, and V. Twersky, 33, 2851-67 (Sep 62). (SA-62-20152; ET-62-4188)

JOURNAL OF APPLIED PHYSICS (CONT.)

7603J "Scattering of a Plane Wave by an Inhomogeneous Sphere Under the Born Approximation," F. A. Albini, 33, 3032-36 (Oct 62). (SA-62-22338)

7604J "Microwave Reflection by Uniform Dense Plasmas," T. Tsukishima and S. Takeda, 33, 3290-91 (Nov 62). (SB-63-583)

7605J "Scattering of Light by Heterogeneous Spheres," R. S. Stein, P. R. Wilson, and S. N. Stidham, 34, 46-50 (Jan 63). (SA-63-9623)

7606J "Microwave Reflection by Nonuniform Plasmas with Exponential Electron Distribution," K. T. Yen, 35, 290-94 (Feb 64). (SB-64-5055; I-A64-14792)

JOURNAL OF THE ATMOSPHERIC SCIENCES

7607J "Radar Measurements of Drop Size Distribution," R. R. Rogers and R. J. Pilie, 19, 503-06 (Nov 62). (SB-63-10709)

7608J "Precipitation Particle Measurements in Cumulus Congestus," E. N. Brown and R. R. Braham, Jr., 20, 23-28 (Jan 63). (I-A63-12767)

7609J "Radar Measurement of Velocities of Meteorological Scatterers," R. R. Rogers, 20, 170-74 (Mar 63). (SB-63-9191; I-A63-16215)

7610J "Radar Observations of Ice Spheres in Free Fall," J. T. Willis, K. A. Browning, and D. Atlas, 21, 103-08 (Jan 64). (SA-64-17884)

7611J "Z-R Relationships Deduced from Forward Scatter Doppler Measurements," L. H. Doherty, 21, 683-97 (Nov 64). (SA-65-10070)

JOURNAL OF ATMOSPHERIC AND TERRESTRIAL PHYSICS (GB)

7612J "The Connection Between Ionospheric Patterns and Field Strengths Reflected on the Ground," J. E. Drummond, 9, Nos. 5/6, 282-94 (Nov 56). (ET-57-916)

7613J "The Frequency Dependence of Radio Reflections from Aurora," P. A. Forsyth and E. L. Vogan, 10, No. 4, 215-28 (1957). (MG-61-12A-75; ET-57-2450)

7614J "Radio Reflections from Aurorae. III. The Association with Geomagnetic Phenomena," K. Bullough, T. W. Davidson, T. R. Kaiser, and C. D. Watkins, 11, Nos. 3/4, 237-54 (1957). (SA-60-797; ET-58-1429)

7615J "Radar Observations of Lightning on 1.5 Metres," J. L. Pawsey, 11, Nos. 3/4, 289-90 (1957). (SA-60-804; MG-58-9.8-104; ET-58-1427)

7616J "Low-Frequency Reflection in the Ionosphere," H. Poeverlein, 12, Nos. 2/3 and 4, 126-39, 236-47 (1958). [Correction: ibid., 12, No. 4, 352]. (MG-59-10.2-177; ET-58-3604)

7617J "A Bistatic Radio Investigation of Auroral Ionization," C. Collins and P. A. Forsyth, 13, Nos. 3/4, 315-45 (Feb 59). (SA-60-6480; ET-59-2001)

7618J "The Effect of Trail Irregularities on the Interpretation of Meteor Echoes," A. G. McNamara and D. W. R. McKinley, 16, Nos. 1/2, 156-59 (Oct 59). (ET-60-480)

7619J "Radio Scattering by Tropospheric Irregularities," A. D. Wheelon, 15, Nos. 3/4, 185-204 (Oct 59). (SA-61-1518)

7620J "Radar Observation of Lightning," M. G. H. Ligda, 15, Nos. 3/4, 248-50 (Oct 59). (SA-61-1516; MG-60-11H-166)

JOURNAL OF ATMOSPHERIC AND TERRESTRIAL PHYSICS (GB) (CONT.)

7621J "Radar Studies of Meteorological 'Angel' Echoes," D. Atlas, 15, Nos. 3/4, 262-87 (Oct 59). (MG-61-12.9-106)

7622J "Turbulence at Altitudes of 80-100 km and Its Effects on Long-Duration Meteor Echoes," J. S. Greenhow and E. L. Neufeld, 16, Nos. 3/4, 384-92 (Nov 59). (ET-60-856)

7623J "Sporadic-E as Observed by Backscatter Techniques in United Kingdom," E. D. R. Shearman and J. Harwood, 18, No. 1, 29-42 (Apr 60). (ET-60-2735)

7624J "The Scattering of 36 Mc/s Radio Waves by Weak Auroral Ionization," J. S. Greenhow, E. L. Neufeld, and C. D. Watkins, 18, Nos. 2/3, 174-80 (Jun 60). (SA-60-16466)

7625J "The Height and Geometry of Auroral Radio Echoes," C. D. Watkins, 19, No. 1, 1-9 (Sep 60). (SA-60-18508; I-61-388; ET-61-199)

7626J "The Magnetic Storm-Time Variation of Radio Star Scintillations and Auroral Radio Echoes," C. D. Watkins, 19, 289-92 (Dec 60). (I-61-2570)

7627J "The Scattering of Radio Waves by an Extended Randomly Refracting Medium," S. A. Bowhill, 20, No. 1, 9-18 (Feb 61). (SB-6412; I-61-2412)

7628J "Auroral Radio-Echoes and Magnetic Disturbances," C. D. Watkins, 20, 131-39 (Mar 61). (I-61-4463; ET-61-1859)

7629J "The Reflection of Radio Waves from an Iceshelf," W. R. Piggott and L. W. Barclay, 20, No. 4, 298-99 (Apr 61). (SA-61-16562; ET-61-2346)

7630J "The Fading of Radio Waves Reflected from the Ionosphere at Oblique Incidence. [Appendix - Small Angle Scattering from Ellipsoidal Irregularities]," O. Awe, 21, 120-41 (Jun 61). (I-61-6319)

7631J "The Fading of Radio Waves Weakly Scattered at Vertical Incidence from Heights Near 90 Km," O. Awe, 21, 142-56 (Jun 61). (I-61-6318)

7632J "The Fading of Radio Waves Reflected Vertically from the Ionosphere During Magnetic Storms," G. F. Fooks, 22, No. 1, 43-49 (Sep 61). (SA-61-20939; I-61-9484)

7633J "Head Echoes from Meteor Trails," J. S. Greenhow, 22, No. 1, 64-73 (Sep 61). (SA-62-4846; I-61-9497; ET-61-4096)

7634J "The Properties of Low Frequency Radio Waves Reflected from the Ionosphere, Calculated by the Phase-Integral Method," E. Cooper, 22, 122-41 (Oct 61). (I-61-10462)

7635J "The Meteoric Head Echo," B. A. McIntosh, 24, 311-15 (Apr 62). (SA-62-11164; I-62-6057; ET-62-2292)

7636J "The Geometry of Radio Reflections from Field-Aligned Ionization Irregularities in the Ionosphere," E. W. Dearden, 24, 375-84 (May 62). (SA-62-9719; I-62-5824)

7637J "Ionospheric Reflection Processes for Long Radio-Waves. I. [Appendix - Asymptotic Analysis of Reflection Density for V.L.F.]," B. S. Westcott, 24, 385-99 (May 62). (I-62-5833)

7638J "Polarization Characteristics of E_S Echoes at Waltair," C. A. Reddy and B. R. Rao, 24, 401-05 (May 62). (ET-62-2668)

JOURNAL OF ATMOSPHERIC AND TERRESTRIAL PHYSICS (GB) (CONT.)

7639J "Some Radar Observations of Meteors and Aurorae at 300 and 500 Mc/s Using a Large Radio Telescope. I. Observations of Meteors," D. Barber, H. K. Sutcliffe, and C. D. Watkins, 24, 585-95 (Jul 62). (SA-62-24172; I-62-9094)

7640J "Some Radar Observations of Meteors and Aurorae at 300 and 500 Mc/s Using a Large Radio Telescope. II. Observations of the Aurora Borealis," D. Barber, H. K. Sutcliffe, and C. D. Watkins, 24, 599-607 (Jul 62). (SA-62-24173; I-62-9119)

7641J "Ionospheric Equivalent Heights of Reflection Calculated by a Full Wave Method and by the Phase Integral Method," K. G. Budden and E. Cooper, 24, 609-18 (Jul 62). (I-62-9110)

7642J "Ionospheric Reflection Processes for Long Radio Waves. II.," B. S. Westcott, 24, 619-31 (Jul 62). (I-62-8908)

7643J "Ionospheric Reflection Processes for Long Radio Waves. III.," B. S. Westcott, 24, 701-13 (Aug 62). (I-62-9857)

7644J "The Propagation of Plane Electromagnetic Waves in a Horizontally Stratified Ionosphere," H. Volland, 24, 853-56 (Oct 62). (SA-63-512)

7645J "On the Scattering of Short Waves from Low Density Meteor Trails," T. Kaliszewski, 24, 1101-03 (Dec 62). (I-A63-13928)

7646J "The Observed Polarisation of High Frequency Radio Waves at a Low Latitude Station," C. A. Reddy and B. R. Rao, 25, 13-22 (Jan 63). (I-A63-12507)

7647J "On the Use of an Asymmetric Model in the Theory of Radio Echo from Meteor Trails," T. Kaliszewski, 25, No. 3, 151-62 (Mar 63). (SA-63-11599; I-A63-15308)

7648J "Ray-Path Calculation of Over-Dense Meteor Echo Strength," L. A. Manning, 25, 182-83 (Mar 63). (I-A63-15313)

7649J "The Electron Scattering Cross-Section in Incoherent Backscatter," J. S. Greenhow, H. K. Sutcliffe, and C. D. Watkins, 25, No. 4, 197-207 (Apr 63). (SB-63-7726)

7650J "Perturbation Methods Applied to the Reflections of Radio Waves from the Ionosphere," P. W. Norman, 25, 319-30 (Jun 63). (I-A63-19602)

7651J "The Structure of E_S at a Low Latitude Station as Deduced from Polarization Observations," C. A. Reddy, 25, No. 7, 387-91 (Jul 63). (SA-64-2297; I-A63-20723)

7652J "High Frequency Exospheric Duct Propagation Experiments," J. A. Thomas, B. A. McInnes, and J. Crouchley, 25, 613-19 (Nov 63). (I-A64-12015)

7653J "Relation Between the Auto-Correlation Coefficients of Singly- and Multiply-Reflected Radio Waves," N. N. Sen and S. R. Khastgir, 26, No. 1, 25-30 (Jan 64). (SA-64-11811; I-A64-14595)

7654J "An Investigation of the Irregularities in the F-Region Associated with Equatorial Type Spread-F," B. R. Clemesha, 26, 91-112 (Jan 64). (I-A64-14601)

7655J "Some Properties of Radio Aurorae in Medium Latitudes," K. Sprenger and P. Glode, 26, 193-98 (Feb 64). (I-A64-16130)

7656J "On the Reflection of Vertically Polarised Electromagnetic Waves from a Horizontally Stratified Medium," R. Burman and R. N. Gould, 26, No. 2, 319-22 (Feb 64). (SA-64-14910; I-A64-16141)

JOURNAL OF ATMOSPHERIC AND TERRESTRIAL PHYSICS (GB) (CONT.)

7657J "The Effect of the Ground Backscatter Coefficient on Observations of Sporadic-E Over Sea, Land and Mountains," J. G. Steele, 26, No. 2, 322-24 (Feb 64). (SA-64-17951)

7658J "Some Electromagnetic Wave Functions for Propagation in Stratified Media," R. N. Gould and R. Burman, 26, 335-40 (Mar 64). (I-A64-16808)

7659J "The Characteristics of Meteor Trails Observed at a Frequency of 300 Mc/s," J. S. Greenhow and C. D. Watkins, 26, 539-58 (May 64). (I-A65-15174)

7660J "Phase Integral Calculations of Ionospheric Reflections Including a Variable Collision Frequency," E. A. Cooper, 26, No. 10, 995-1005 (Oct 64). (SA-65-13446)

JOURNAL OF THE BRITISH INSTITUTION OF RADIO ENGINEERS

7661J "Radar Contact with Venus," V. A. Kotel'nikov, 22, No. 4, 293-95 (Oct 61). [Discussion: ibid., 300-03]. (I-61-10536; ET-62-103)

7662J "Radar Measurements of the Planet Venus," L. R. Malling and S. W. Golomb, 22, 297-300 (Oct 61). (I-61-10535; ET-62-104)

7663J "The Portrayal of Body Shape by a Sonar or Radar System," A. Freedman, 25, 51-64 (Jan 63). (SB-63-4899; I-A63-12947)

JOURNAL OF THE BRITISH INTERPLANETARY SOCIETY

7664J "Surface Roughness of the Moon," H. S. Hayre, 18, 389-91 (Jul-Aug 62). (I-A63-10812)

JOURNAL OF CHEMICAL PHYSICS

7665J "Theoretical Investigations on the Light Scattering of Colloidal Spheres. XI. Determination of Size Distribution Curves from Spectra of the Scattering Ratio or from Depolarization Spectra," A. F. Stevenson, W. Heller, and M. L. Wallach, 34, 1789-95 (May 61). (SA-61-8239)

7666J "Theoretical Investigations on the Light Scattering of Spheres. XIII. The 'Wavelength Exponent' of Differential Turbidity Spectra," W. Heller, H. L. Bhatnagar, and M. Nakagaki, 36, 1163-70 (Mar 62). (SA-62-7404)

7667J "Theoretical Investigations on the Light Scattering of Spheres. XIV. Wavelength Exponent of Differential Scattering Spectra for an Angle of Observation of 90°," H. L. Bhatnagar and W. Heller, 40, 480-83 (Jan 64). (SA-64-8455)

JOURNAL OF THE FRANKLIN INSTITUTE

7668J "The Characteristics of an Electromagnetic Wave Reflected from a Moving Object," C. F. Cole, Jr., 265, 463-72 (Jun 58). (SA-58-6078; ET-59-410)

7669J "Statistical Radar Estimate of the Lunar Surface Roughness," H. S. Hayre, 277, 197-205 (Mar 64). (I-A64-16333)

JOURNAL OF GEOMAGNETISM AND GEOELECTRICITY (JAPAN)

7670J "The Scattering of Electromagnetic Waves by Plasma Oscillations," N. Hokkyo, 8, No. 1, 1-8 (Mar 56). (MG-60-11E-66; ET-57-1565)

JOURNAL OF GEOPHYSICAL RESEARCH

7671J "Doppler Shifted Radio Echoes from Aurora," K. L. Bowles, 59, 553-55 (Dec 54). (MG-61-12A-33)

7672J "Calculations of Ionospheric Reflection Coefficients at Very Low Radio Frequencies," J. R. Wait and L. B. Perry, 62, 43-56 (Mar 57). (ET-57-2449)

7673J "Meteor Echoes at Ultra High Frequencies," W. A. Flood, 62, 79-91 (Mar 57). (SA-58-3646; MG-57-8H-93; ET-57-2577)

7674J "The Geometry of Auroral Ionization," T. R. Kaiser, 62, 297-98 (Jun 57). (ET-57-3141)

7675J "Discussion of the Booker and Cohen Paper, 'A Theory of Long-Duration Meteor Echoes Based on Atmospheric Turbulence with Experimental Confirmation,'" L. A. Manning and V. R. Eshleman, 62, 367-71 (Sep 57). (SA-58-4641)

7676J "U.H.F. Radar Observations of Aurora," S. J. Fricker, R. P. Ingalls, M. L. Stone, and S. C. Wang, 62, 527-46 (Dec 57). (SA-58-5556; MG-61-12A-79; ET-58-1430)

7677J "V.H.F. Radar Echoes Associated with Atmospheric Phenomena," G. C. Rumi, 62, 547-64 (Dec 57). (SB-58-4429; ET-58-1432)

7678J "The Role of F-Layer Tilts in Detection of Auroral Ionization," S. Stein, 63, 391-404 (Jun 58). (ET-58-3094)

7679J "The Geometry of Auroral Ionization," R. S. Unwin, 63, 501-06 (Sep 58). (SA-59-1965; ET-59-137)

7680J "V.H.F. Observations on the Aurora Australis," T. J. Seed, 63, 517-26 (Sep 58). (SA-59-1966; ET-59-141)

7681J "Electromagnetic Scattering by Low-Density Meteor Trails," H. Brysk, 63, 693-716 (Dec 58). (SA-59-3675; ET-59-1665)

7682J "Concerning Booker's Theory of Meteoric Reflections," L. A. Manning and V. R. Eshleman, 63, 737-39 (Dec 58). (ET-59-1527)

7683J "U.H.F. Auroral Radar Observations," B. C. Blevis, 63, 867-68 (Dec 58). (ET-59-1573)

7684J "Optical, Electromagnetic, and Satellite Observations of High-Altitude Nuclear Detonations: Part 2," A. M. Peterson, 64, 933-38 (Aug 59). (ET-60-162)

7685J "VHF and UHF Radar Observations of the Aurora at College, Alaska," R. I. Presnell, R. L. Leadabrand, A. M. Peterson, et al., 64, 1179-90 (Sep 59). (MG-60-11H-119; ET-60-521)

7686J "High-Altitude 106.1-Mc/s Radio Echoes from Auroral Ionization Detected at a Geomagnetic Latitude of 43°," J. C. Schlobohm, R. L. Leadabrand, R. B. Dyce, et al., 64, 1191-96 (Sep 59). (SA-60-10441; ET-60-522)

7687J "Doppler Investigations of the Radar Aurora at 400 Mc/s," R. L. Leadabrand, R. I. Presnell, M. R. Berg, and R. B. Dyce, 64, 1197-1203 (Sep 59). (SA-60-10442; MG-61-12A-129; ET-60-523)

7688J "Subhorizon Radar Echoes by Scatter Propagation," D. Atlas, 64, 1205-18 (Sep 59). (SB-60-4496; MG-60-11H-3; ET-60-640)

7689J "Air Motions and the Fading, Diversity, and Aspect Sensitivity of Meteoric Echoes," L. A. Manning, 64, 1415-27 (Oct 59).

JOURNAL OF GEOPHYSICAL RESEARCH (CONT.)

7690J "Radio Scattering in the Lower Ionosphere," H. G. Booker, 64, 2164-77 (Dec 59).

7691J "The Spectrum of X-Band Radiation Back-Scattered from the Sea Surface," B. L. Hicks, N. Knable, J. J. Kovaly, et al., 65, 825-37 (Mar 60). (SA-60-12700; ET-60-2758)

7692J "Ionospheric Back-Scatter Observations at 440 Mc/s," V. C. Pineo, L. G. Kraft, and H. W. Briscoe, 65, 1620-21 (May 60). (ET-60-3641)

7693J "Scattering of Radio Waves by Electrons Above the Ionosphere," E. E. Salpeter, 65, 1851-52 (Jun 60). (SA-60-18501)

7694J "Radio Echoes from Field-Aligned Ionization Above the Magnetic Equator and Their Resemblance to Auroral Echoes," K. L. Bowles, R. Cohen, G. R. Ochs, and B. B. Balsley, 65, 1853-55 (Jun 60). (SA-60-18490; ET-60-3640)

7695J "Direct H.F. Backscatter from the F Region," H. F. Bates, 65, 1993-2002 (Jul 60). (SB-60-6397)

7696J "41-Mc/s I.G.Y. Auroral Radar at Ithaca, New York," C. W. Gartlein, G. Sprague, and R. C. Waag, 65, 2255-59 (Aug 60). (ET-60-4250)

7697J "Simultaneous V.H.F. Auroral Backscatter Measurements," W. A. Flood, 65, 2261-68 (Aug 60). (SA-60-16467; ET-60-4251)

7698J "Theory of Spread F Based on Aspect-Sensitive Backscattered Echoes," J. Renau, 65, 2269-77 (Aug 60). (SA-60-16449)

7699J "Some Characteristics of Ionospheric Back-Scatter Observed at 440 Mc/s," V. C. Pineo, L. G. Kraft, and H. W. Briscoe, 65, 2629-33 (Sep 60). (SA-61-20910; MG-61-12.4-130; ET-61-188)

7700J "Radio-Wave Scattering by an Ionized Gas in Thermal Equilibrium," J. A. Fejer, 65, 2635-36 (Sep 60). (ET-61-191)

7701J "Evidence That the Moon is a Rough Scatterer at Radio Frequencies," R. L. Leadabrand, R. B. Dyce, A. Fredriksen, et al., 65, 3071-78 (Oct 60). (SA-61-15556; MG-60-11L-125; MG-61-12K-155)

7702J "Radar Methods of Measuring the Cislunar Electron Density," V. R. Eshleman, P. B. Gallagher, and R. C. Barthle, 65, 3079-86 (Oct 60). (ET-61-536)

7703J "A Lunar and Planetary Echo Theory," W. E. Brown, Jr., 65, 3087-95 (Oct 60). (SA-61-15559; MG-60-11L-122; MG-61-12K-142; ET-61-537)

7704J "Scattering of Electromagnetic Waves from a Nondegenerate Ionized Gas," J. Renau, 65, 3631-40 (Nov 60). (ET-61-1021)

7705J "Radio Wave Reflections from the Mesosphere. I - Heights of Occurrence," J. B. Gregory, 66, 429-45 (Feb 61). (MG-62-13.4-104; I-61-4266)

7706J "Some Properties of Radio Waves Reflected from the Moon and Their Relation to the Lunar Surface," T. Hagfors, 66, 777-85 (Mar 61). (SA-61-15558; MG-62-13.10-134; I-61-4264; ET-61-2186)

7707J "Effect of the Magnetic Field in Ionospheric Back-Scatter," E. E. Salpeter, 66, 982-84 (Mar 61). (SA-61-20920; ET-61-2213)

7708J "The Effect of Faraday Rotation on Incoherent Backscatter Observations," G. H. Millman, A. J. Moceyunas, A. E. Sanders, and R. F. Wyrick, 66, 1564-68 (May 61). (SA-61-20923)

JOURNAL OF GEOPHYSICAL RESEARCH (CONT.)

7709J "A Theory of Radar Reflection from the Moon and Planets," F. B. Daniels, 66, 1781-88 (Jun 61). (SA-61-15557; MG-61-12K-177; I-61-6316; ET-61-3372)

7710J "A Possible Explanation of the Long-Duration Radar Echoes of Ionized Trails in the Upper Atmosphere," C. L. Tang, 66, 1974-75 (Jun 61). (MG-62-13.8-197; ET-61-3377)

7711J "The Spectrum and the Total Intensity of Electromagnetic Waves Scattered from an Ionized Gas in Thermal Equilibrium in the Presence of a Static Quasi-Uniform Magnetic Field," J. Renau, H. Camnitz, and W. Flood, 66, 2703-32 (Sep 61). (SA-61-19041; I-61-9272; ET-62-270)

7712J "V.L.F. Ionospheric Reflection Coefficients--Derivation from Impedance Concepts and Values for Some Model Ionospheres," E. C. Field and P. Tamarkin, 66, 2737-50 (Sep 61). (ET-62-278)

7713J "An H. F. Radar Search for Possible Effects of Earth Satellites Upon the Upper Atmosphere," T. A. Croft and O. G. Villard, Jr., 66, 3109-18 (Oct 61). (SA-62-2495)

7714J "Back-Scattering of 3.21-Centimeter Radiation by Water Bubbles," L. J. Battan and B. M. Herman, 66, 3255-59 (Oct 61). (SA-62-1603; ET-62-664)

7715J "Discussion of Incoherent Backscatter Power Measurements at 440 Mc/s," V. C. Pineo and H. W. Briscoe, 66, 3965-66 (Nov 61). (SA-62-7767; ET-62-1040)

7716J "Radar Reflections from the Sun at Very High Frequencies," W. G. Abel, J. H. Chisholm, P. L. Fleck, and J. C. James, 66, 4303-07 (Dec 61). (SA-62-9113; ET-62-1251)

7717J "Argus Radar Returns in Conjugate Area," P. Newman, 67, 407-08 (Jan 62). (ET-62-1571)

7718J "A Theory of Radar Reflections from the Moon and Planets," V. A. Hughes and F. B. Daniels, 67, 892-95 (Feb 62). (ET-62-1912)

7719J "Distribution of Radar Auroras Over Alaska," R. S. Leonard, 67, 939-52 (Mar 62). (SB-62-10087; I-62-5042)

7720J "Evidence That Meteor Trails Produce a Field-Aligned Scatter Signal at V.H.F.," J. L. Heritage, W. J. Fay, and E. D. Bowen, 67, 953-64 (Mar 62). (SB-62-10075; I-62-4834)

7721J "On the Scattering of Electromagnetic Waves by Nonisotropic Inhomogeneities in the Atmosphere," D. T. Gjessing, 67, 1017-26 (Mar 62). (SA-62-11796; MG-62-13.9-110)

7722J "Pulsed Radio Soundings of the Topside of the Ionosphere in the Presence of Spread F," R. W. Knecht and S. Russell, 67, 1178-82 (Mar 62). (SB-62-10089)

7723J "Evidence of Low-Frequency Amplitude Fluctuations in Radar Auroral Echoes," R. S. Leonard, 67, 1683-84 (Apr 62). (ET-62-2679)

7724J "Scattering of Radiation by the Fluctuations in a Nonequilibrium Plasma," O. Buneman, 67, 2050-53 (May 62). (I-62-6591; ET-62-3141)

7725J "A Geometrical Optics Approach for the Radar Cross Section of Thin Shells," L. Peters, Jr., and D. T. Thomas, 67, 2073-75 (May 62). (I-62-6784)

7726J "Radio Echoes from Field-Aligned Ionization at the Magnetic Equator," W. Ireland and J. Mawdsley, 67, 2583-85 (Jun 62). (I-62-8091; ET-62-3375)

JOURNAL OF GEOPHYSICAL RESEARCH (CONT.)

7727J "Scattering and Conversion Cross Sections in Inhomogeneous Plasma," M. H. Cohen, 67, 2729-39 (Jul 62). (SA-63-499; I-62-8915)

7728J "The Cross Section for Scattering of Electromagnetic Waves from an Ionized Gas in Thermal Nonequilibrium," J. Renau, 67, 3624-26 (Aug 62). (SA-63-6975; ET-62-4189)

7729J "Radio Echoes from a Manned Satellite During Re-entry," S. C. Lin, 67, 3851-70 (Sep 62). (SB-63-5368; I-62-11271)

7730J "Enhancement of Radar Reflectivity Associated with the Lunar Crater Tycho," G. H. Pettengill and J. C. Henry, 67, 4881-85 (Nov 62). (SA-63-9267; I-A63-10529)

7731J "Spectral Widths and Shapes and Other Characteristics of Incoherent Backscatter from the Ionosphere Observed at 440 Megacycles Per Second During a 24-Hour Period in May 1961," V. C. Pineo and D. P. Hynek, 67, 5119-29 (Dec 62). (SA-63-7720; I-A63-10958)

7732J "The Radar Cross Sections of 'Spongy' Ice Spheres," L. J. Battan and B. M. Herman, 67, 5139-45 (Dec 62).

7733J "The Scattering Behavior of the Moon at Wavelengths of 3.6, 68, and 784 Centimeters," J. V. Evans and G. H. Pettengill, 68, 423-47 (Jan 63). (SA-63-11598; I-A63-11651)

7734J "Radar Determination of the Root Mean Square Slope of the Lunar Surface," F. B. Daniels, 68, 449-53 (Jan 63) [Comments: ibid., 68, 2864-65 (May 63)]. (SA-63-11597; SA-64-2457; I-A63-11652)

7735J "The Effect of the Earth's Magnetic Field on Irregularities of Ionization in the E Layer," F. Villars and H. Feshbach, 68, 1303-20 (Mar 63). (I-A63-14516)

7736J "Geomagnetic Effects on the Frequency Spectrum of Incoherent Backscatter Observed at 425 Megacycles Per Second at Trinidad," V. C. Pineo and D. P. Hynek, 68, 2695-2706 (May 63). (SA-64-2268; I-A63-16743)

7737J "Terminal Fall Velocity of Radar Chaff," J. E. Jiusto and W. J. Eadie, 68, 2858-61 (May 63). (SB-63-15935; I-A63-16751)

7738J "Radio-Frequency Backscatter of Artificial Electron Clouds," P. B. Gallagher and R. A. Barnes, 68, 2987-3010 (May 63). (SA-64-2269; I-A63-22951)

7739J "Characteristics of Spread F at High Geomagnetic Latitude," W. K. Klemperer, 68, 3191-96 (May 63). (I-A63-22967)

7740J "Radar Detection of Ionized Nitric Oxide in the Lower Ionosphere," L. Colin, A. A. Burns, and V. R. Eshleman, 68, 4382-87 (Jul 63). (SA-64-2281; I-A63-20163)

7741J "On the Power Scattered from Density Fluctuations in a Plasma," D. R. Moorcroft, 68, 4870-72 (Aug 63). (SA-64-2983; I-A63-21415)

7742J "The Radar Cross-Section of the Moon," J. V. Evans and G. H. Pettengill, 68, 5098-99 (Sep 63). (SA-64-4939; I-A63-22364)

7743J "Ionospheric Disturbances Associated with Echo 1 as Studied with 19-Megacycle-Per-Second Radar," M. E. Tiuri and J. D. Kraus, 68, 5371-85 (Oct 63). (SA-64-7907; I-A63-23364)

7744J "A Theory of Incoherent Scattering of Radio Waves by a Plasma. III. Scattering in a Partly Ionized Gas," J. P. Dougherty and D. T. Farley, Jr., 68, 5473-86 (Oct 63). (SA-64-5623; I-A63-23372)

JOURNAL OF GEOPHYSICAL RESEARCH (CONT.)

7745J "Radar Reflections from a Rough Moon Described by a Composite Correlation Function," F. B. Daniels, 68, 6251-54 (Dec 63). (SB-64-6595; I-A64-11581)

7746J "A H.F. Backscatter Study of Solar Eclipse Effects Upon the Ionosphere," J. R. Davis, V. C. Headrick, and J. L. Ahearn, 69, 190-93 (Jan 64). (SA-65-13436)

7747J "S-Band Auroral Radar Returns," L. H. Groth, L. J. Anderson, C. C. Easterbrook, and L. R. Burdette, 69, 194-96 (Jan 64). (I-A64-13817)

7748J "The Effect of Coulomb Collisions on Incoherent Scattering of Radio Waves by a Plasma," D. T. Farley, Jr., 69, 197-99 (Jan 64). (SA-65-11715)

7749J "Identification of Ionospheric Motions Detected by the High-Frequency Backscattering Technique," A. F. Wickersham, Jr., 69, 457-64 (Feb 64). [Comments: ibid., C. O. Hines, 69, 2395-96 (Jun 64); A. F. Wickersham, Jr., 69, 2397-98 (Jun 64); L. H. Heisler, 69, 5105-07 (Dec 64); A. F. Wickersham, Jr., 69, 5108-11 (Dec 64)]. (SA-65-13454; SA-65-13455; SA-65-13456; SA-65-13457; SA-65-13458)

7750J "Radar Doppler Measurements of the Cislunar Medium," H. T. Howard, P. Yoh, and V. R. Eshleman, 69, 535-39 (Feb 64). (I-A64-14174)

7751J "Radar Observations of the Moon at a Wavelength of 8.6 Millimeters," V. L. Lynn, M. D. Sohigian, and E. A. Crocker, 69, 781-83 (Feb 64). (SA-65-15827; I-A64-15365)

7752J "Backscatter of Electromagnetic Radiation from a Turbulent Plasma," E. E. Salpeter and S. B. Treiman, 69, 869-81 (Mar 64). (I-A64-15255)

7753J "Theory of Radar Scatter from Rough Surfaces, Bistatic and Monostatic, with Application to Lunar Radar Return," A. K. Fung, 69, 1063-73 (Mar 64). (SA-65-14109; I-A64-15729)

7754J "Effects of Structure Size on Moon and Earth Radar Returns at Various Angles," A. K. Fung and R. K. Moore, 69, 1075-81 (Mar 64). (SA-65-15830; I-A64-15730)

7755J "Evidence of a Stratified Echoing Region at 150 Kilometers in the Vicinity of the Magnetic Equator During Daylight Hours," B. B. Balsley, 69, 1925-30 (May 64). (SA-65-13396; I-A64-17927)

7756J "Radar Reflectivity of Storms Containing Spongy Hail," D. Atlas, K. R. Hardy, and J. Joss, 69, 1955-61 (May 64). (I-A64-18719)

7757J "Absolute Scattering Functions and Transmission Values for Interpreting Laser Light Scattering in the Mesophere," E. P. Palmer and W. G. Zdunzkowski, 69, 2369-78 (Jun 64). (SA-65-13373)

7758J "A Study of Auroral Echoes at 19.4 Megacycles Per Second," C. Malik and J. Aarons, 69, 2731-36 (Jul 64). (SA-65-13391; I-A64-22132)

7759J "Study of the Lower Ionosphere Using Partial Reflection. I. Experimental Technique and Method of Analysis," J. S. Belrose and M. J. Burke, 69, 2799-2818 (Jul 64). (SA-65-13477)

7760J "An Investigation of Mie and Rayleigh Backscattering at 3.2- and 10.3-Centimeter Wavelengths," V. M. H. Von, R. A. Clark, J. J. Stephens, and V. E. Moyer, 69, 2873-80 (Jul 64). (SA-65-10551; I-A64-22922)

7761J "Lunar Radio-Reflection Properties at Decameter Wavelengths," J. R. Davis and D. C. Rohlfs, 69, 3257-62 (Aug 64). (SA-65-15828; I-A64-23632)

JOURNAL OF GEOPHYSICAL RESEARCH (CONT.)

7762J "Backscattering from an Undulating Surface with Applications to Radar Returns from the Moon," 69, 3779-84 (Sep 64). (SA-65-10550; I-A64-26098)

7763J "Incoherent Scatter Observations of Traveling Ionospheric Disturbances," G. D. Thome, 69, 4047-49 (Oct 64). (SA-65-13452; I-A64-27056)

7764J "The Analysis of Radar Echoes from the Moon," D. G. Rea, N. Hetherington, and R. Mifflin, 69, 5217-23 (Dec 64). (SA-65-15829; I-A65-13509)

JOURNAL OF THE INSTITUTE OF ELECTRICAL COMMUNICATION ENGINEERS OF JAPAN

7765J "Rainfall Measurement by Meteorological Radar Equipment," N. Kodaira, 39, 121-26 (Feb 56). (SB-57-1694)

7766J "Back-Scattering of a Thin, Dielectric, Spherical Shell," A. Yokoyama, 42, 170-73 (Feb 59). (SB-59-5256)

7767J "Equivalent Reflection Coefficient in 9 Gc/s Band Propagation Over Snow-Covered Terrain," M. Suzuki, 42, 490-96 (May 59). (SB-59-6754)

7768J "Theory of Scattering by Thin Dielectric Shells," A. Yokoyama, 44, 1049-56 (Jul 61). (SB-62-5302)

7769J "Back-Scattering Cross-Sections of Multiple Metallic Sphere Arrays," N. Kumagai, 44, 1166-73 (Aug 61). (SB-62-8232)

7770J "Diffraction of Plane Electromagnetic Waves from a Conductive Circular Cylinder of Finite Length," K. Aoki, 44, 1341-46 (Sep 61). (SB-62-12433)

7771J "The Measurement of Attenuation by Rain at 8.6 mm Wavelength," S. Okamura, K. Funakawa, H. Uda, et al., 45, 757-63 (Jun 62). (SB-63-12850)

7772J "Surface Roughness and Effective Reflection Coefficients of the Sea in 9 Gc/s-Band Wave Propagation," T. Marukawa, 45, 1071-75 (Aug 62). (SB-63-9162)

JOURNAL OF THE INSTITUTE OF NAVIGATION (GB)

7773J "Some Practical Experience of Sea Clutter," E. M. Robb, 7, No. 4, 362-64 (Oct 54). (MG-61-12M-809)

7774J "The Sea Surface and Doppler," C. S. Durst, 11, No. 2, 143-45 (Apr 58). (ET-58-3097)

JOURNAL OF THE INSTITUTION OF ELECTRICAL ENGINEERS (GB)

7775J "Sounding the Ionosphere by Incoherent Scatter at Very High Frequencies," E. D. R. Shearman, 9, 432-36 (Oct 63). (I-A64-11203)

JOURNAL OF THE INSTITUTION OF TELECOMMUNICATION ENGINEERS (INDIA)

7776J "Microwave Properties of Metal-Flake Artificial Dielectrics," Krishnaji and S. Swarup, 6, No. 1, 38-46 (Dec 59). (SB-60-6941)

7777J "Flutter Fading of Short-Wave Radio Signals in Equatorial Regions and Its Connection with Spread Echoes, Magnetic Storms and the Radiation Belt," C. Lal, 6, No. 5, 223-30 (Aug 60). (SB-62-2187)

7778J "Role of Tropospheric Scatter in Radar Propagation," D. B. Rai, 7, No. 5, 220-25 (Sep 61). (SB-62-2216)

JOURNAL OF MATHEMATICAL ANALYSIS AND APPLICATIONS

7779J "On the Exterior Boundary Value Problem of Perfect Reflection for Stationary Electromagnetic Wave Fields," P. Werner, 7, 348-96 (Dec 63).

JOURNAL OF MATHEMATICAL PHYSICS

7780J "Higher-Order Approximations in Multiple Scattering. I. Two-Dimensional Scalar Case," N. Zitron and S. N. Karp, 2, 394-402 (May-Jun 61). (SA-61-6934)

7781J "Higher-Order Approximations in Multiple Scattering. II. Three-Dimensional Scalar Case," N. Zitron and S. N. Karp, 2, 402-06 (May-Jun 61). (SA-61-6935)

7782J "Multiple Scattering by Arbitrary Configurations in Three Dimensions," V. Twersky, 3, 83-91 (Jan-Feb 62). (SA-62-2599)

7783J "On Scattering of Waves by Random Distributions. I. Free-Space Scatterer Formalism," V. Twersky, 3, 700-15 (Jul-Aug 62). (SA-62-19381)

7784J "On a General Class of Scattering Problems," V. Twersky, 3, 716-23 (Jul-Aug 62). (SA-62-19383)

7785J "On Scattering of Waves by Random Distributions. II. Two-Space Scatterer Formalism," V. Twersky, 3, 724-34 (Jul-Aug 62). (SA-62-19382)

7786J "The Diffraction of Waves by a Penetrable Ribbon," C. Yeh, 4, 65-71 (Jan 63). (SA-63-7699)

7787J "Zeros of Hankel Functions and Poles of Scattering Amplitudes," J. B. Keller, S. I. Rubinow, and M. Goldstein, 4, 829-32 (Jun 63). (SA-63-17053)

7788J "Diffraction by Polygonal Cylinders," B. J. Morse, 5, 199-214 (Feb 64). (SA-64-11798)

7789J "Scattering of Electromagnetic Waves by a Composite Cylinder," M. A. Islam, 5, 550-57 (Apr 64). (SA-64-16652)

7790J "Diffraction by a Smooth Transparent Object," Y. M. Chen, 5, 820-32 (Jun 64). (SA-64-18033)

7791J "Multiple Scattering of Waves. II. 'Hole Corrections' in the Scalar Case," J. G. Fikioris and P. C. Waterman, 5, 1413-20 (Oct 64). (SA-65-28)

7792J "On Scattering of Waves by Objects Imbedded in Random Media: Stochastic Linear Partial Differential Equations and Scattering of Waves by Conducting Sphere Imbedded in Random Media," Y. M. Chen, 5, 1541-46 (Nov 64). (SA-65-2259)

7793J "Multiple Scattering of Electromagnetic Waves by Random Scatterers of Finite Size," N. C. Mathur and K. C. Yeh, 5, 1619-28 (Nov 64). (SA-65-2260)

7794J "Effect of Small Irregularities on Electromagnetic Scattering from an Interface of Arbitrary Shape," K. M. Mitzner, 5, 1776-86 (Dec 64). (SA-65-4958)

JOURNAL OF MATHEMATICS AND MECHANICS

7795J "Wave Propagation Around a Convex Cylinder," E. Zauderer, 13, 171-86 (Mar 64). (I-A64-16867)

7796J "Wave Propagation Around a Smooth Object," E. Zauderer, 13, 187-99 (Mar 64). (SA-65-2256)

JOURNAL OF MATHEMATICS AND PHYSICS

7797J "Reflection and Refraction of Electromagnetic Waves at Plane Interfaces," W. E. Williams, 36, 26-35 (Apr 57). (ET-57-3833)

7798J "A Variational Solution to the Problem of Scalar Scattering by a Prolate Spheroid," F. Sleator, 39, 105-20 (Jul 60).

JOURNAL OF METEOROLOGICAL RESEARCH (JAPAN)

7799J "Radio Duct Seen on a Weather Radar PPI-Scope," M. Onuki, 10, 517-24 (1958).

JOURNAL OF THE METEOROLOGICAL SOCIETY OF JAPAN

7800J "Attenuation of Microwaves Through Rain for Various Drop-size Distributions," I. Imai, 65-71 (Nov 57). [75th anniversary volume]. (MG-60-11H-69)

JOURNAL OF METEOROLOGY

7801J "Drop Size and Radar Structure of a Precipitation Streamer," D. Atlas, 14, 261-71 (Jun 57). (MG-57-8.10-242)

7802J "Comments on H. J. aufm Kampe: Upper-Air Wind Measurements with Small Rockets," A. D. Anderson, 14, 473-74 (Oct 57). (MG-58-9.2-142)

7803J "Cumulus Cloud Precipitation as Revealed by Radar-Arizona 1955," R. R. Braham, Jr., 15, 75-83 (Feb 58). (MG-59-10.1-130)

7804J "Radar Echoes from a Cloudless Cold Front," M. G. H. Ligda and S. G. Bigler, 15, 494-501 (Dec 58). (SB-59-2525; MG-59-10.7-139)

7805J "Meteorological 'Angel' Echoes," D. Atlas, 16, 6-11 (Feb 59). (MG-59-10.7-136; ET-59-2603)

7806J "On the Origin of Hurricane Spiral Rain Bands," H. V. Senn amd H. W. Hiser, 16, 419-26 (Aug 59). (MG-60-11H-133)

7807J "Radar Indications of a Precipitation-Lightning Relationship in New England Thunderstorms," C. R. Shackford, 17, 15-19 (Feb 60). (MG-60-11H-136)

7808J "Possible Key to the Dilemma of Meteorological 'Angel' Echoes," D. Atlas, 17, 95-103 (Apr 60). (MG-60-11H-4)

7809J "Radar Detection of the Sea Breeze," D. Atlas, 17, 244-58 (Jun 60). (MG-60-11H-165)

7810J "Radar Reflectivity Profiles in Thunderstorms," R. J. Donaldson, Jr., 18, 292-305 (Jun 61). (I-61-8452; ET-62-156)

7811J "Experimental Determinations of the Back-Scattering Cross-Sections of Water Drops and of Wet and Dry Ice Spheres at 3.2 Centimeters," J. R. Gerhardt, C. W. Tolbert, S. A. Brunstein, et al., 18, 340-47 (Jun 61). (MG-62-13.1-495)

7812J "Radar Cross-Sections for Water and Ice Spheres," J. J. Stephens, 18, 348-59 (Jun 61). (I-61-8439)

7813J "Calculations of Mie Back-Scattering from Melting Ice Spheres," B. M. Herman and L. J. Battan, 18, 468-78 (Aug 61). (SA-61-19032)

7814J "Note Concerning the Mie Scattering of Unpolarized Incident Radiation," B. M. Herman, 18, 558-60 (Aug 61). (SA-61-18617)

7815J "Further Studies of the Back-Scattering Cross-Sections of Water Drops and Wet and Dry Ice Spheres, J. R. Gerhardt, C. W. Tolbert, and S. A. Brunstein, 18, 688-91 (Oct 61). (SA-62-4597)

JOURNAL OF THE OPTICAL SOCIETY OF AMERICA

7816J "New Tables of Total Mie Scattering Coefficients for Spherical Particles of Real Refractive Indexes ($1.33 \leq n \leq 1.50$)," R. B. Penndorf, 47, 1010-15 (Nov 57). (ET-58-1705)

7817J "Scattering and Absorption of Electromagnetic Radiation by Infinite Cylinders," B. K. Larkin and S. W. Churchill, 49, 188-90 (Feb 59). (SA-59-5552)

7818J "Light Scattering Functions for Spherical Particles with m = 1.75," E. J. Meehan and W. H. Beattie, 49, 735 (Jul 59). (SA-59-9527)

7819J "Reflection and Refraction at a Random Moving Surface. I. Pattern and Paths of Specular Points," M. S. Longuet-Higgins, 50, 838-44 (Sep 60). (SA-60-14788)

7820J "Reflection and Refraction at a Random Moving Surface. II. Number of Specular Points in a Gaussian Surface," M. S. Longuet-Higgins, 50, 845-50 (Sep 60). (SA-60-14789)

7821J "Reflection and Refraction at a Random Moving Surface. III. Frequency of Twinkling in a Gaussian Surface," M. S. Longuet-Higgins, 50, 851-55 (Sep 60). (SA-60-14790)

7822J "Mie Scattering Functions for Refractive Index of 2.105," M. Kerker and E. Matijevic, 51, 87-92 (Jan 61). (MG-62-13.4-468)

7823J "Scattering of Electromagnetic Waves from Concentric Infinite Cylinders," M. Kerker and E. Matijevic, 51, 506-08 (May 61). (SA-61-8241; ET-61-4072)

7824J "Mie Scattering with Complex Index of Refraction," D. Deirmendjian, R. Clasen, and W. Viezee, 51, 620-33 (Jun 61). (SA-61-8238; MG-62-13.4-467)

7825J "Fraunhofer Diffraction of an Electromagnetic Wave," B. Karczewski, 51, 1055-57 (Oct 61). (SA-61-13181)

7826J "Radar Contrast Patterns of Airport Runways," F. Richey, 52, 51-57 (1962). (SB-62-3220; I-62-2530)

7827J "Geometrical Theory of Diffraction," J. B. Keller, 52, 116-30 (Feb 62). (SA-62-2894)

7828J "Scattering of Waves and Particles by Inhomogeneous Regions," L. I. Schiff, 52, 140-44 (Feb 62). (SA-62-2598)

7829J "Multiple Scattering of Waves and Optical Phenomena," V. Twersky, 52, 145-71 (Feb 62). (SA-62-2898)

7830J "Consistency of Rayleigh's Diffraction Formulas with Kirchhoff's Boundary Conditions," N. Mukunda, 52, 336-37 (Mar 62). (SA-62-7400)

7831J "Early History of the Mie Solution," N. A. Logan, 52, 342-43 (Mar 62). (SA-62-7405)

7832J "Angular Mie Scattering," R. Penndorf, 52, 402-07 (Apr 62). (SA-62-7406)

7833J "Generalization of the Maggi-Rubinowicz Theory of the Boundary Diffraction Wave. I.," K. Miyamoto and E. Wolf, 52, 615-25 (Jun 62). (SA-62-13456)

7834J "Generalization of the Maggi-Rubinowicz Theory of the Boundary Diffraction Wave. II.," K. Miyamoto and E. Wolf, 52, 626-37 (Jun 62). (SA-62-13457)

7835J "Elementary Results for Scattering by Large Cones," J. E. Burke, L. Mower, and V. Twersky, 52, 1093-1107 (Oct 62). (SA-62-19729)

JOURNAL OF THE OPTICAL SOCIETY OF AMERICA (CONT.)

7836J "Far-Field Diffraction and Polarization Properties of a Three-Dimensional Hollow, Homogeneous, Isotropic Cone," A. I. Mahan and L. P. Bone, 53, 533-44 (May 63). (SA-63-12311)

7837J "Applicability of Rayleigh-Gans Scattering to Spherical Particles," M. Kerker, W. A. Farone, and E. Matijevic, 53, 758-59 (Jun 63). (SA-63-19447)

7838J "Boundary Wave in Electromagnetic Theory of Diffraction," B. Karczewski, 53, 878-79 (Jul 63). (I-A63-20180)

7839J "Diffraction of Plane Waves by a Slit Between Two Different Media," R. Barakat, 53, 1231-43 (Nov 63). (SA-64-5812; I-A63-26063)

7840J "General Solution of the Diffraction Integral for a Rectangular Aperture in the Presence of Aberrations," H. P. Greinel, 54, 32-37 (Jan 64). (I-A64-13036)

7841J "Comparison of the Kirchhoff and the Rayleigh-Sommerfeld Theories of Diffraction at an Aperture," E. Wolf and E. W. Marchand, 54, 587-94 (May 64). (SA-64-16249)

7842J "On Scattering of Waves by an Elliptic Cylinder and by a Semielliptic Protuberance on a Ground Plane," J. E. Burke and V. Twersky, 54, 732-44 (Jun 64). (SA-64-19227; I-A64-19918)

7843J "Diffraction Anomalies with a Dielectric Grating," C. H. Palmer and F. C. Evering, Jr., 54, 844-45 (Jun 64). (SA-64-21315)

7844J "Scattering of Electromagnetic Radiation by Infinitely Long, Hollow, and Coated Cylinders," L. B. Evans, J. C. Chen, and S. W. Churchill, 54, 1004-07 (Aug 64). (SA-64-27653)

7845J "Scattering Patterns for Elliptic Cylinders," J. E. Burke, E. J. Christensen, and S. B. Lyttle, 54, 1065-66 (Aug 64). (SA-64-30053)

7846J "Diffraction of Plane Electromagnetic Waves by a Perfectly Conducting Cylindrical Lamina," R. Barakat and E. Levin, 54, 1089-94 (Sep 64). (SA-64-27647; I-A64-24116)

7847J "Diffraction by a Circular Aperture," R. W. Dunham, 54, 1102-05 (Sep 64). (SA-64-27649)

7848J "Scattering of Obliquely Incident Light Waves by Elliptical Fibers," C. Yeh, 54, 1227-31 (Oct 64). (SA-64-29772)

7849J "Approximate Formula for the Total Scattering of Electromagnetic Radiation by Spheres," C. Smart and V. Vand, 54, 1232-34 (Oct 64). (SA-64-29773)

JOURNAL OF THE PHYSICAL SOCIETY OF JAPAN

7850J "Diffraction of Electromagnetic Waves by Ribbon and Slit. I.," Y. Nomura and S. Katsura, 12, 190-200 (Feb 57). (SA-58-4180)

7851J "Scattering of Microwaves from a Cylindrical Plasma in the Born Approximation. I.," Y. Midzuno, 16, 971-80 (May 61). (SA-61-16568; ET-61-3727)

7852J "Scattering of Microwaves from a Cylindrical Plasma in the Born Approximation. II.," Y. Midzuno, 16, 1403-17 (Jul 61). (SA-61-16569; ET-62-457)

7853J "Scattering of Microwaves from a Cylindrical Plasma in the Born Approximation. III.," Y. Midzuno, 17, 1299-1303 (Aug 62). (I-62-9597; ET-62-4007)

JOURNAL OF THE PHYSICAL SOCIETY OF JAPAN (CONT.)

7854J "Diffraction of Electromagnetic Waves from an Electric Dipole by a Conducting Circular Disc," S. Inawashiro, 18, 273-87 (Feb 63). (SA-63-12312; I-A63-13910)

7855J "Simultaneous Wiener-Hopf Equations and Their Application to Diffraction Problems in Electromagnetic Theory," A. Igarashi, 19, 1213-21 (Jul 64). (SA-64-27643)

JOURNAL DE PHYSIQUE ET LE RADIUM (FRANCE)

7856J "Apparatus for the Experimental Study of the Diffraction of Centimetre Waves," J. Mevel, 18, Supplement to No. 3, Phys. Appl., 45A-53A (Mar 57). (ET-58-1393)

7857J "Study of the Detailed Structure of the Curves for Scattering of Electromagnetic Waves by Dielectric Spheres," J. Mevel, 19, No. 7, 630-36 (Jul 58). (SA-59-5962)

7858J "An Apparatus for the Study of Polarization by Diffraction of Centimetric Electromagnetic Waves," A. Mevel and J. Mevel, 19, Supplement to No. 12, Phys. Appl., 133A-139A (Dec 58). (SA-60-17105; ET-61-1129)

JOURNAL AND PROCEEDINGS OF THE ROYAL SOCIETY OF NEW SOUTH WALES (AUSTRALIA)

7859J "Reflection of Plane Waves by Random Cylindrical Surfaces," L. G. MacCracken, 95, Pt. 1, 43-46 (1961). (SA-61-16561)

JOURNAL OF THE RADIO RESEARCH LABORATORIES (JAPAN)

7860J "On the Measurement of Attenuation by Rain at 8.6 mm Wave Length," S. Okamura, K. Funakawa, H. Uda, et al., 6, 255-67 (Apr 59). (SB-60-5802)

7861J "Attenuation of Electromagnetic Wave Due to Rain with Distorted Raindrops," T. Oguchi, 7, 467-85 (Sep 60). (ET-61-1977)

7862J "Effect of Polarization on the Attenuation by Rain at Millimeter-Wave Length," S. Okamura, K. Funakawa, H. Uda, et al., 8, 73-80 (Mar 61). (SB-62-6063)

7863J "Statistical Fluctuation of Amplitude and Phase of Radio Signals Passing Through the Rain," T. Oguchi, 9, 51-72 (Jan 62). (SB-63-5374)

7864J "On the Mechanism of Ionospheric Multiple Reflections," R. Nishizaki, S. Ito, T. Mori, et al., 9, 339-47 (Jul 62). (SB-63-5382)

7865J "Attenuation of Electromagnetic Wave Due to Rain with Distorted Raindrops. II.," T. Oguchi, 11, 19-44 (Jan 64). (SB-65-1329; I-A64-19720)

7866J "On the Observation of the Upper Atmospheric Constituents by Laser Beams," M. Hirono, 11, 251-71 (Jul 64). (SA-65-13464; I-A65-14683)

JOURNAL OF RESEARCH OF THE NATIONAL BUREAU OF STANDARDS

7867J "On the Diffraction and Reflection of Waves and Pulses by Wedges and Corners," F. Oberhettinger, 61, 343-65 (Nov 58). (SA-59-3669)

7868J "Transmission and Reflection by a Parallel Wire Grid," M. T. Decker, 63D, 87-90 (Jul-Aug 59). (SB-59-6763; ET-60-107)

7869J "Diffraction of Electromagnetic Waves by Smooth Obstacles for Grazing Angles," J. R. Wait and A. M. Conda, 63D, 181-97 (Sep-Oct 59). (SA-60-3858; ET-60-109)

7870J "Radio-Wave Scattering by Tropospheric Irregularities," A. D. Wheelon, 63D, 205-33 (Sep-Oct 59). (SB-60-1860)

JOURNAL OF RESEARCH OF THE NATIONAL BUREAU OF STANDARDS (CONT.)

7871J "Study at 1046 Megacycles Per Second of the Reflection Coefficient of Irregular Terrain at Grazing Angles," R. E. McGavin and L. J. Maloney, 63D, 235-48 (Sep-Oct 59). (ET-60-312)

7872J "A Theory of Radar Scattering by the Moon," T. B. A. Senior and K. M. Siegel, 64D, 217-29 (May-Jun 60). (SA-60-16525; MG-60-11H-130; ET-60-3826)

7873J "On the Theory of Reflection of Low- and Very-Low Radio Frequency Waves from the Ionosphere," J. R. Johler and L. C. Walters, 64D, 269-85 (May-Jun 60). (SA-60-17122)

7874J "Diffraction by Smooth Conical Obstacles," H. E. J. Neugebauer and M. P. Bachynski, 64D, 317-29 (Jul-Aug 60). (SA-60-12697; ET-60-4191)

7875J "Characteristics of 488 Megacycles Per Second Radio Signals Reflected from the Moon," B. C. Blevis and J. H. Chapman, 64D, 331-34 (Jul-Aug 60). (SB-60-5219; MG-60-11.12-76; ET-60-4207)

7876J "Computation and Measurement of the Fading Rate of Moon-Reflected UHF Signals," S. J. Fricker, R. P. Ingalls, W. C. Mason, et al., 64D, 455-65 (Sep-Oct 60). (MG-60-11L-124)

7877J "On the Theory of Wave Propagation Through a Concentrically Stratified Troposphere with a Smooth Profile. I. Discussion of the Extended W.K.B. Approximation," H. Bremmer, 64D, 467-82 (Sep-Oct 60). (SA-62-3172)

7878J "Polarization and Depression-Angle Dependence of Radar Terrain Return," I. Katz and L. M. Spetner, 64D, 483-86 (Sep-Oct 60). (SB-62-2217; ET-61-208)

7879J "Diffraction and Scattering," L. B. Felsen and K. M. Siegel, 64D, 707-14 (Nov-Dec 60). (SA-62-7402)

7880J "Multiple Scattering of Waves," V. Twersky, 64D, 715-30 (Nov-Dec 60). (SA-62-7408)

7881J "Incoherent Scattering by Free Electrons as a Technique for Studying the Ionosphere and Exosphere: Some Observations and Theoretical Considerations," K. L. Bowles, 65D, 1-14 (Jan-Feb 61). (SB-61-1652; I-61-1831)

7882J "On the Theory of Diffraction by a Composite Cylinder," R. D. Kodis, 65D, 19-33 (Jan-Feb 61). (SA-61-4722; ET-61-1801)

7883J "Ionospheric Motions Observed with High-Frequency Back-Scatter Sounders," L. H. Tveten, 65D, 115-27 (Mar-Apr 61). (I-61-4442; ET-61-2212)

7884J "Fresnel Region Fields of a Circular Aperture Antenna," M. K. Hu, 65D, 137-47 (Mar-Apr 61).

7885J "Theoretical Scattering Coefficient for Near Vertical Incidence from Contour Maps," H. S. Hayre and R. K. Moore, 65D, 427-32 (Sep-Oct 61). (SB-62-7241; I-61-9268; ET-62-154)

7886J "Radar Corner Reflectors for Linear or Circular Polarization," G. Latmiral and A. Sposito, 66D, 23-29 (Jan-Feb 62). (SA-62-16034; ET-62-2334)

7887J "Reflection of Electromagnetic Waves from Thin Ionized Gaseous Layers," F. H. Northover, 66D, 73-80 (Jan-Feb 62). (SA-62-16035; I-62-3628)

7888J "Reflection and Transmission of Radio Waves at a Continuously Stratified Plasma with Arbitrary Magnetic Induction," J. R. Johler and J. D. Harper, Jr., 66D, 81-99 (Jan-Feb 62). (SB-62-11349; I-62-3630)

JOURNAL OF RESEARCH OF THE NATIONAL BUREAU OF STANDARDS (CONT.)

7889J "A Theory of Radar Reflections from a Rough Moon," D. F. Winter, 66D, 215-26 (May-Jun 62). (SA-62-15402; I-62-6853; ET-62-4032)

7890J "A Lunar Theory Reasserted," K. M. Siegel and T. B. A. Senior, 66D, 227-29 (May-Jun 62). [Comments: J. V. Evans, ibid., 67D, 1-4 (Jan-Feb 63)]. (SA-62-15403; I-62-6852; I-A63-11885)

7891J "Statistical Distribution of the Amplitude and Phase of a Multiply Scattered Field," P. Beckmann, 66D, 231-40 (May-Jun 62). (SB-62-10080; ET-62-4201)

7892J "On the Role of the Process of Reflection in Radio Wave Propagation," F. du Castel, P. Misme, A. Spizzichino, and J. Voge, 66D, 273-84 (May-Jun 62). (SB-62-10078; I-62-6854)

7893J "On the Absolute Intensity of Incoherent Scatter Echoes from the Ionosphere," K. L. Bowles, G. R. Ochs, and J. L. Green, 66D, 395-407 (Jul-Aug 62). (SB-62-11353; I-62-8075)

7894J "Scattering from a Conducting Sphere Embedded in a Semi-Infinite Dissipative Medium," J. Galejs, 66D, 607-12 (Sep-Oct 62). (SA-63-497; I-62-9854; ET-62-4003)

7895J "High-Frequency Scattering from a Coated Sphere," V. H. Weston and R. Hemenger, 66D, 613-19 (Sep-Oct 62). (SA-63-498; I-62-9853; ET-62-4004)

7896J "On the Geometrical Optics of Curved Surfaces with Periodic Impedance Properties," C. J. Marcinkowski and L. B. Felsen, 66D, 699-705 (Nov-Dec 62). (SB-63-3867)

7897J "On the Limitations of Geometrical Optics Solutions for Curved Surfaces with Variable Impedance Properties," C. J. Marcinkowski and L. B. Felsen, 66D, 707-12 (Nov-Dec 62). (SB-63-3868)

7898J "Composition of Reflection and Transmission Formulae," J. Heading, 67D, 65-77 (Jan-Feb 63). (SB-63-5393; I-A63-11890)

7899J "Radar Reflections from the Moon at 425 Mc/s," G. H. Millman and F. L. Rose, 67D, 107-17 (Mar-Apr 63). (SA-63-11596; I-A63-13523)

7900J "Some Wave Functions and Potential Functions Pertaining to Spherically Stratified Media," C. T. Tai, 67D, 199-202 (Mar-Apr 63). (SB-63-5570)

7901J "On the Statistical Theory of Electromagnetic Waves in a Fluctuating Medium. I.," K. Furutsu, 67D, 303-23 (May-Jun 63). (SA-63-21973; I-A63-18084)

7902J "Analysis and Synthesis of Nonuniform Transmission Lines or Stratified Layers," G. Latmiral, G. Franceschetti, and R. Vinciguerra, 67D, 331-45 (May-Jun 63). (I-A63-18086)

7903J "Reflection of V.L.F. Radio Waves from an Inhomogeneous Ionosphere. I. Exponentially Varying Isotropic Model," J. R. Wait and L. C. Walters, 67D, 361-67 (May-Jun 63). (SB-63-12290; I-A63-18089)

7904J "Some Implication of Aircraft Interference Patterns in Troposcatter Reception," J. A. Bradshaw, 67D, 405-15 (Jul-Aug 63). (I-A63-20999)

7905J "A Dipole Approximation of the Backscattering from a Conductor in a Semi-Infinite Dissipative Medium," M. B. Kraichman, 67D, 433-43 (Jul-Aug 63). (SA-63-21976; I-A63-21001)

7906J "Reflection of V.L.F. Radio Waves from an Inhomogeneous Ionosphere. II. Perturbed Exponential Model," J. R. Wait and L. C. Walters, 67D, 519-23 (Sep-Oct 63). (SA-64-3186; I-A63-25324)

7907J "Reflection of V.L.F. Radio Waves from an Inhomogeneous Ionosphere. III. Exponential Model with Hyperbolic Transition," J. R. Wait and L. C. Walters, 67D, 747-52 (Nov-Dec 63). (SA-64-8956; I-A64-10345)

7908J "Statistical Methods in Radar Astronomy. Determination of Surface Roughness," H. S. Hayre, 67D, 763-64 (Nov-Dec 63). (SB-64-1318; I-A64-10347)

7909J "Reflection of Electromagnetic Waves from a Lossy Magnetoplasma," J. R. Wait and L. C. Walters, 68D, 95-101 (Jan 64). (I-A64-14695)

7910J "Calculations of the Bistatic Scattering Cross Section of a Sphere with an Impedance Boundary Condition," J. R. Wait and C. M. Jackson, 68D, 299-316 (Feb 64). (SA-65-10549)

7911J "A Simplified Theory of Diffraction at an Interface Separating Two Dielectrics," J. Kane and S. N. Karp, 68D, 303-10 (Mar 64). (SB-64-6081; I-A64-15846)

7912J "A Light-Modulated Scattering Technique for Diffraction Field Measurements," A. M. Vural and D. K. Cheng, 68D, 355-62 (Apr 64). [A paper of this same title also appeared in Proc. of the National Electronics Conference, 19, 39-51 (1963)]. (SA-64-24841; I-A64-17492)

7913J "Propagation of Electromagnetic Waves Through a Continuously Varying Stratified Anisotropic Medium," G. H. Price, 68D, 407-18 (Apr 64). (I-A64-17495)

7914J "Statistical Problems in Electromagnetics," W. S. Ament, 68D, 451-54 (Apr 64). (SB-65-579)

7915J "Electromagnetic Fields in Lossy Media," J. R. Wait, 68D, 463-65 (Apr 64). (SB-64-12354)

7916J "Electromagnetic Wave Propagation in Inhomogeneous Plasmas and/or Magnetoplasmas," W. C. Hoffman, 68D, 486-89 (Apr 64). (SB-64-15279)

7917J "Classical Diffraction and Scattering," L. B. Felsen and V. H. Weston, 68D, 490-99 (Apr 64). (SA-64-30051)

7918J "On Scattering of Waves by Many Bodies," J. E. Burke and V. Twersky, 68D, 500-10 (Apr 64). (SB-64-15283)

7919J "Passive and Active Reflectors," J. Kaiser and I. Kay, 68D, 515-17 (Apr 64). (SB-64-12776)

7920J "Radar Meteorology and Cloud Physics," S. G. Bigler, et al., 68D, 555-57 (May 64). (SB-64-12823)

7921J "Influence of Irregularities of Terrain and of Vegetation on Radio Wave Propagation," A. W. Straiton, et al., 68D, 560-63 (May 64). (SB-64-14265)

7922J "Radar Studies of the Sun, Moon, and Planets," J. H. Chisholm, G. H. Pettengill et al., 68D, 565-67 (May 64). (SB-64-12828)

7923J "Electrical Properties of Sea Ice at 0.1 to 30 Mc/s," F. L. Wentworth and M. Cohn, 68D, 681-91 (Jun 64). (SB-64-10880)

7924J "Wave Propagation in Stratified Random Media," Y. M. Chen, 68D, 743-48 (Jun 64). (SB-64-11062)

7925J "Radar Scattering from Coated Perfect Conductors: Application to the Semi-Infinite Cone and Use of Exact Eikonal," H. Uberall, 68D, 749-66 (Jun 64). (SA-64-24844; I-A64-19745)

JOURNAL OF RESEARCH OF THE NATIONAL BUREAU OF STANDARDS (CONT.)

7926J "A Note on V.H.F. Reflection from a Tropospheric Layer," J. R. Wait, 68D, 847-48 (Jul 64). (SA-64-26801)

7927J "Some Remarks on the Use of Statistics in Radar Astronomy," I. Kay, 68D, 849-50 (Jul 64). (SB-64-12814)

7928J "Angels, Insects, and Weather," A. H. LaGrone, A. P. Deam, and G. B. Walker, 68D, 895-901 (Aug 64). (SB-64-12815; I-A64-24251)

7929J "Measurement of the Attenuation of Radio Signals by Jungles," J. W. Herbstreit and W. Q. Crichlow, 68D, 903-06 (Aug 64). (SB-64-12779)

7930J "Rayleigh Distribution and Its Generalizations," P. Beckmann, 68D, 927-32 (Sep 64). (SA-64-27640; I-A64-25751)

7931J "Random Volume Scattering," H. Bremmer, 68D, 967-81 (Sep 64). (SA-64-27026; I-A64-25755)

7932J "Spectral Measurement Techniques in Planetary Radar," G. Pettengill, 68D, 1025-29 (Sep 64). (SB-64-14330; I-A64-25762)

7933J "Statistics of Random Surfaces. I - Outline of Random Surface Theory and Applications. II - Distribution of Specular Points on a Rough Spherical Surface," I. Kay and P. Swerling, 68D, 1035-47 (Sep 64). (SA-64-27652; I-A64-25764)

7934J "Modified Gaussian Distributions for Slightly Nonlinear Variables," M. S. Longuet-Higgins, 68D, 1049-62 (Sep 64). (SB-64-14140)

7935J "Theoretical Heights and Durations of Echoes from Large Meteors," L. A. Manning, 68D, 1067-78 (Oct 64). (SB-64-15991; I-A65-10127)

7936J "Experimental Determination of Meteoric Line Densities and Attachment Rates," L. A. Manning, 68D, 1079-93 (Oct 64). (SB-64-15992)

7937J "Electromagnetic Scattering Coefficients for Concentric Spheres and the Problem of Interference Free Enclosures," R. A. Eldred, H. A. Lasitter, and J. Roberts, 68D, 1145-54 (Oct 64). (SA-64-30055; I-A65-10134)

7938J "On the Theory of Reflection of Electromagnetic Waves from the Interface Between a Compressible Magnetoplasma and a Dielectric," J. R. Wait, 68D, 1187-91 (Nov 64). (SA-65-6009; I-A65-12462)

7939J "Some Approximate Formulas Concerning the Reflection of Electromagnetic Waves from a Stratified Semi-Infinite Medium," R. Burman, 68D, 1215-18 (Nov 64). (SA-65-7998; I-A65-12465)

JOURNAL OF THE SOCIETY FOR INDUSTRIAL AND APPLIED MATHEMATICS

7940J "Multiple Scattering in One Dimension," J. Bazer, 12, 539-79 (Sep 64). (SA-65-13825; I-A65-14430)

KUNGLIGA TEKNISKA HOGSKOLANS HANDLINGAR (SWEDEN)

7941J "Exact Solution of the Antenna Equation," E. Hallen, No. 183, (1961).

MARCONI REVIEW (GB)

7942J "Weather and Radar," G. C. Rider, 26, 144-62 (1963). (SB-63-12319)

MARINE OBSERVER (GB)

7943J "Phosphorescence [and Radar]. Gulf of Oman," F. G. Baker, 22, 190-92 (Oct 52). (MG-58-9E-18)

7944J "Phosphorescence and Radar [in] Equatorial Pacific Waters," F. G. Baker, 25, 149-50 (Jul 55). (MG-58-9E-18)

7945J "Radar Performance in Sand and Dust Storms," 29, 82 (Apr 59). (MG-60-11H-122)

MEMOIRES DE LA CLASSE DES SCIENCES DE L'ACADEMIE ROYALE DE BELGIQUE (COLLECTION IN 4°) (BELGIUM)

7946J "Scattering of Light by Spherical Particles with a Refractive Index m = 1.33," L. Houziaux and L. Battiau, 14, No. 4, 33 pp (1958). (SA-58-5817)

MEMOIRS OF THE COLLEGE OF SCIENCE, UNIVERSITY OF KYOTO, SERIES A (JAPAN)

7947J "Diffraction of Electromagnetic Waves by a Circular Cylinder of Infinite Length," I. Takahashi, T. Watanabe, and K. Tanimoto, 28, No. 3, 209-19 (Sep 57). (SB-59-2206)

MEMOIRS OF THE DEFENSE ACADEMY (JAPAN)

7948J "The Model Experiments of the Radar Cross Section of the Aircraft by the Ultrasonic Wave in Air," T. Kuyama and C. Suzuki, 1, No. 1, 106-17 (Oct 61). (SB-62-14349)

7949J "Effective Reflection Coefficient and Propagation of Radar Waves on Sea Surface in 3.2 cm Wave-Length," T. Marukawa, 2, No. 2, 75-88 (Apr 62). (SB-63-7794)

7950J "Experimental Research on Circularly Polarized Wave Propagation Over Sea Surface in 3.2 cm Wave-Length," T. Marukawa, 2, No. 3, 1-7 (Nov 62). (SB-63-9161)

METEOROLOGICAL ABSTRACTS AND BIBLIOGRAPHY

7951J "Recent Literature on Radar Meteorology," G. Thuronyi, 9, 1005-30 (Aug 58). (MG-60-11H-147)

METEOROLOGICAL AND GEOASTROPHYSICAL ABSTRACTS

7952J "Recent Literature on Radar Meteorology," A. J. Meglis and R. Panara, 11, 1307-45 (Aug 60). (I-61-3487)

7953J "Bibliography on Aurora," A. J. Meglis, 12, 129-80 (Jan 61). (I-61-7465)

7954J "Bibliography on the Physics of Auroras," A. J. Meglis, 12, 339-81 (Feb 61). (I-61-7464)

METEOROLOGICAL MAGAZINE (GB)

7955J "Wind Measurement by Doppler Radar," P. G. F. Caton, 92, 213-22 (Jul 63). (I-A63-22096)

METEOROLOGIIA I GIDROLOGIIA (USSR)

7956J "Measurements of the Intensity of Precipitation by Means of Radar," V. M. Muchnik, No. 7, 50-54 (Jul 58). (MG-60-11H-108)

MICHIGAN MATHEMATICAL JOURNAL

7957J "Diffraction by Thin Elliptic Cylinders," R. F. Goodrich and N. D. Kazarinoff, 10, 105-27 (1963).

MICROWAVE JOURNAL

7958J "Techniques for Measurement of Reduced Radar Cross Sections. I.," C. G. Bachman, H. E. King, and R. C. Hansen, 6, 61-66 (Feb 63). (SB-63-10721)

7959J "Techniques for Measurement of Reduced Radar Cross Sections. II.," C. G. Bachman, H. E. King, and R. C. Hansen, 6, 95-101 (Mar 63). (SB-63-10722)

7960J "A New Type of Omni-Azimuthal Radar-Echo Enhancer," J. Croney and W. D. Delany, 6, 105-09 (Mar 63). (SB-63-9196)

7961J "Techniques for Measurement of Reduced Radar Cross Sections. III.," C. G. Bachman, H. E. King, and R. C. Hansen, 6, 80-86 (Apr 63). (SB-63-10723)

7962J "A Review of Electromagnetic Propagation in Plasmas," P. P. Keenan, 7, 56-60 (Sep 64). (SB-65-582)

7963J "35 and 70 Gc Phase-Locked C.W. Balanced-Bridge Model Measurement Radars," W. E. Blore, P. E. Robillard, and R. I. Primich, 7, 61-65 (Sep 64). (SB-65-1366)

MICROWAVES

7964J "High Resolution Backscatter Techniques," R. Honer and R. Hively, 2, 18-23 (Apr 63).

7965J "Designing Foamed-Plastic Target Supports," T. B. A. Senior, M. A. Plonus, and E. F. Knott, 3, 38-43 (Dec 64).

MISSILI (ITALY)

7966J "Reflection Characteristics of Aerial Targets," M. Busco, 4, 47-54 (Jun 62). (I-A63-10015)

MONTHLY NOTICES OF THE ROYAL ASTRONOMICAL SOCIETY (GB)

7967J "The Scattering of Radio Waves in the Solar Corona," A. Hewish, 118, No. 6, 534-46 (1958). (ET-59-2939)

7968J "The Variation of Meteor Heights with Velocity and Magnitude," J. S. Greenhow and J. E. Hall, 121, No. 2, 174-82 (1960). (ET-61-854)

7969J "The Importance of Initial Trail Radius on the Apparent Height and Number Distributions of Meteor Echoes," J. S. Greenhow and J. E. Hall, 121, No. 2, 183-96 (1960). (ET-61-856)

7970J "Radar Observations of Venus and a Determination of the Astronomical Unit, 1962," J. E. B. Ponsonby, J. H. Thomson, and K. S. Imrie, 128, No. 1, 1-17 (1964). (I-A64-24254)

MONTHLY WEATHER REVIEW

7971J "A Non-Tornadic Spiral-Shaped Radar Echo," L. E. Fortner, Jr., and C. L. Jordan, 88, 343-48 (Sep-Dec 60). (I-61-1124)

7972J "Use of Doppler Radar in Meteorological Observations," R. L. Smith and D. W. Holmes, 89, 1-7 (Jan 61). (I-61-2593)

NACHRICHTENTECHNISCHE FACHBERICHTE (NTF) (GERMANY)

7973J "Analogies in Measurements for Acoustic and Electric Waves of Equal Wavelengths," G. Kurtze, 20, 6-10 (1961). (SB-63-4701)

NACHRICHTENTECHNISCHE ZEITSCHRIFT (NTZ) (GERMANY)

7974J "Dielectric Walls with Low Microwave Reflection," H. Meinke, 10, 551-58 (Nov 57). [Trans: OTS or SLA 59-19490]. (SB-58-3844; TT-61/2-59-19490)

7975J "Double Refraction of Ultra Short Waves Through Vegetation," H. U. Widdel, 15, 649-50 (Dec 62). (SB-64-1233)

7976J "The Backscattering Cross Section of Plates and Cylinders as a Function of the Incident Angle of Radiation," J. Schindelin, 16, 486-89 (Sep 63). (SB-64-3988; I-A63-24424)

7977J "Radar Echoing Area and Reflective Properties of Radar Reflectors and Aircraft Targets," P. J. Muenzer, 17, 201-05 (Apr 64). (SB-65-1362; I-A64-18535)

7978J "Radar Echo Area and Reflection Properties of Radar Reflectors and Aircraft Targets," P. J. Muenzer, 17, 245-54 (May 64). (SB-65-1384; I-A64-20318)

7979J "Radar Cross Section and Reflection Properties of Radar Reflectors and Aircraft Targets. III - Omnidirectional Reflectors Using Dielectric Lenses," P. J. Muenzer, 17, 287-91 (Jun 64). (SB-65-4910; I-A64-23142)

7980J "Radar Cross Section and Reflection Properties of Radar Reflectors and Aircraft Targets. IV - Spherically Symmetric Dielectric Lenses," P. Muenzer, 17, 349-50 (Jul 64). (I-A64-27849)

7981J "Investigation of the Structure of the Troposphere with a Vertically Directed Radar," L. Fehlhaber and J. Grosskopf, 17, 503-07 (Oct 64). (I-A64-28566)

NATURE (GB)

7982J "Reflexion of Radio Waves from the Moon," F. J. Kerr and C. A. Shain; J. D. Kraus, 179, 433 (Feb 57). (SA-57-5801; ET-57-2117)

7983J "'Angels' on Centimetric Radars Caused by Birds," W. G. Harper, 180, 847-49 (Oct 57). (SB-58-1032; MG-58-9.2-276; ET-58-1158)

7984J "Comparison of Measured and Computed Values of the Rapid Fading Rate of Ultra-High-Frequency Signals Reflected from the Moon," S. J. Fricker, R. P. Ingalls, W. C. Mason, and M. L. Stone, 182, 1438-39 (Nov 58). (ET-59-1525)

7985J "Movement of Auroral Echoes and the Magnetic-Disturbance Current System," R. S. Unwin, 183, 1044-45 (Apr 59). (ET-59-2593)

7986J "Radio Reflexions from the Moon and Solar Corona," O. Burkard, 183, 1180 (Apr 59). (ET-59-2583)

7987J "'Ring Angels' Over South-East England," E. Eastwood, J. D. Bell, and N. R. Phelp, 183, 1759-60 (Jun 59). (SB-59-6788; MG-60-11H-42; ET-59-2982)

7988J "Radar Echoing Area Polar Diagram of Birds," J. Edwards and E. W. Houghton, 184, 1059 (Oct 59). (SB-60-1880; MG-60-11H-43; ET-60-174)

7989J "Radio Echo Observations of Venus," J. V. Evans and G. N. Taylor, 184, 1358-59 (Oct 59). (SA-60-4872; MG-60-11L-121; MG-61-12J-51; ET-60-479)

7990J "Radar 'Ring Angels' and the Roosting Movements of Starlings," E. Eastwood, G. A. Isted, and G. C. Rider, 186, 112-14 (Apr 60). (SB-60-4497; ET-60-2025)

NATURE (GB) (CONT.)

7991J "Roughness of the Moon as a Radar Reflector," V. A. Hughes, 186, 873-74 (Jun 60). (SA-60-14384; MG-61-12K-151; ET-60-3079)

7992J "Radar Determination of the Scattering Properties of the Moon," F. B. Daniels, 187, 399 (Jul 60). (SA-60-18651; MG-62-13.4-100; ET-60-3477)

7993J "Roughness of the Moon as a Radar Reflector," B. H. Briggs, 187, 490 (Aug 60). [Correction: ibid., 187, 466 (Aug 60)]. (SA-60-18652; ET-60-3476)

7994J "Radar Echoes from the Aurora at 1300 Mc/s," E. Eastwood, G. A. Isted, and J. D. Bell, 189, 115-17 (Jan 61). (I-61-4436; ET-61-1176)

7995J "A Radar Observation of a Sea-Breeze Front," E. Eastwood and G. C. Rider, 189, 978-80 (Mar 61). (SB-61-6461; ET-61-1870)

7996J "Irregularities in the E_S Layer of the Ionosphere," G. F. Fooks, 190, 707-08 (May 61). (I-61-6552)

7997J "Radar Reflectivities of Hail Samples," R. H. Douglas, 191, 266-67 (Jul 61). (MG-62-13.7-459)

7998J "Scattering of Radio Waves in the Ionosphere," B. R. Clemesha and R. W. Wright, 193, 54-55 (Jan 62). (SA-62-4638; I-62-2548)

7999J "Identification of Sporadic-E from Low-Frequency Sweep Polarization Records," A. J. Ferraro and C. P. Tou, 193, 461-62 (Feb 62). (I-62-3911)

8000J "Radar Observations of Meteor Echoes at a Frequency of 1300 Mc/s," J. S. Greenhow, H. K. Sutcliffe, and C. D. Watkins, 193, 1036-37 (Mar 62). (SA-62-13178; I-62-4995; ET-62-1913)

8001J "Optical Echoes from the Moon," L. D. Smullin and G. Fiocco, 194, 1267 (Jun 62). (I-62-8151)

8002J "Simultaneous Radar and Refractometer Soundings of the Troposphere," J. A. Lane and R. W. Meadows, 197, 35-36 (Jan 63). (SA-63-9051)

8003J "Backscatter of Radio Waves from the Equatorial F-Region," B. R. Clemesha, 199, 797-98 (Aug 63). (SA-64-7928; I-A63-23806)

8004J "Laser Radar Echoes from the Clear Atmosphere," R. T. H. Collis and M. G. H. Ligda, 203, 508 (Aug 64). (SA-65-4473; I-A64-23517)

8005J "Laser Radar Echoes from a Stratified Clear Atmosphere," R. T. H. Collis, F. G. Fernald, and M. G. H. Ligda, 203, 1274-75 (Sep 64). (SA-65-13247; I-A64-27413)

NAUCHNO-ISSLEDOVATEL'SKII INSTITUT ZEMNOGO MAGNETIZMA, IONOSFERY I RASPROSTRANENIYA RADIOVOLN. [LENINGRAD], TRUDY (USSR)

8006J "Correlation Function of the Amplitudes of Signals Scattered from an Absolutely Rough Screen," I. S. Vsekhsvyatskaya and E. E. Tsedilina, 17, No. 27, 287-91 (1960). [Trans: OTS or SLA 62-13626; AD 262 421]. (TT-62/1-62-13626)

NOTE RECENSIONI E NOTIZIE (ITALY)

8007J "The Calculation of the Coefficients of Reflection from the Ground," C. Rudilosso, 6, No. 6, 848-60 (Nov-Dec 57). (ET-58-3229)

NUBILA (ITALY)

8008J "Some Properties of Convective Clouds," L. J. Battan, 4, No. 1, 1-12 (1961). (MG-62-13.10-619)

8009J "Radar Back Scattering from Oblate Spheroids," W. G. Harper, 5, No. 1, 60-72 (1962). (I-A63-10937)

NUCLEAR FUSION (INTERNAT.)

8010J "Interaction Between an Electromagnetic Wave and a Bounded Plasma," E. P. Fetisov, 3, 208-14 (Sep 63). (SA-64-8714)

NUKLEONIKA (POLAND)

8011J "Interaction of an H.F. Electromagnetic Field with a Plasma Cylinder," S. Khvashchtevski, 7, No. 6, 369-77 (1962). (SB-63-587)

IL NUOVO CIMENTO (ITALY)

8012J "Multiple Small-Angle Scattering of Waves by an Inhomogeneous Medium," P. Gosar, 4, 688-702 (Oct 56). (ET-57-1885)

8013J "The Determination of the Scattering Potential from the Spectral Measure Function. Part IV. 'Pathological' Scattering Problems in One Dimension," I. Kay and H. E. Moses, 5, Series 10, 230-42 (1957).

8014J "Babinet's Principle for Diffraction at a Plane Screen with Directional Conductivity," G. Toraldo di Francia, 9, 309-15 (Jul 58). (SA-58-8164)

8015J "Diffraction of a Plane Electromagnetic Wave by Cylinders with Anisotropic Conductivity," R. E. Kelly and A. Russek, 16, 593-610 (May 60). (SA-60-15146; ET-61-833)

8016J "On the Diffraction of a Pulse by a Half-Plane," R. C. T. Da Costa, 25, 69-85 (Jul 62). (SA-62-17957)

SUPPLEMENTO AL NUOVO CIMENTO (ITALY)

8017J "Multiple Scattering by a Random Stack of Dielectric Slabs," I. Kay and R. A. Silverman, 9, Supplement No. 2, 626-45 (1958). [In English]. (ET-61-2546)

L'ONDE ELECTRIQUE (FRANCE)

8018J "On Certain Methods of Analysis of Relations Obtained with the Aid of the W.K.B. Method," K. Bochenek, 37, 462-64 (May 57). (SB-57-6367)

8019J "Effective Radar Cross-Sections of Meteor Trails," H. Brysk, C. E. Schensted, I. V. Schensted, and K. M. Siegel, 37, 520-22 (May 57). (SB-57-6419)

8020J "Some Absorbent Materials at U.H.F.," H. G. Stubbs and J. Peyssou, 38, 809-18 (Dec 58). (SB-59-7024; ET-61-831)

8021J "Electromagnetic Waves and Satellites. High-Frequency Echoes from Ionized Trails of Satellites," A. Flambard and M. Reyssat, 38, 830-37 (Dec 58). (SA-60-15; ET-61-865)

8022J "Experimental Study of Spherical Dielectric Lenses and Reflectors," B. Chiron and F. Holvoet-Vermaut, 41, 481-89 (May 61). (SB-62-1191)

OPTICA ACTA (GB)

8023J "Multiple Diffraction by an Aperture in a Hard Screen," S. N. Karp and J. B. Keller, 8, 61-72 (Jan 61).

8024J "Scattering of Evanescent Waves by Cylindrical Structures," L. Ronchi, V. Russo, G. Toraldo di Francia, and C. Zaccagnini, 8, 281-99 (Oct 61). (SA-62-3169)

OPTIK (GERMANY)

8025J "Derivation of Three-Dimensional Diffraction Solutions for Plane Electromagnetic Waves from Two-Dimensional Solutions," H. Stockel, 19, 3-7 (Jan 62). (SA-62-7755; ET-62-2253)

OPTIKA I SPEKTROSKOPIYA (USSR) [Cover-to-Cover Translation]

8026J "Scattering of Inhomogeneous Electromagnetic Waves by Spherical Particles," O. A. Germogenova and G. V. Rozenberg, 14, 125-30 (Jan 63). (SA-63-17054; I-A63-19696)

PAPERS IN METEOROLOGY AND GEOPHYSICS (JAPAN)

8027J "On the Scattering of the Plane Electromagnetic Wave by a Continuous Inhomogeneity with Spherical Symmetry in a Homogeneous Medium," K. Naito, 3, No. 4, 313-19 (Mar 53). (MG-57-8J-26)

8028J "Measurement of Snowfall Intensity by Radar," N. Kodaira and M. Inaba, 6, No. 2, 126-29 (Sep 55). (MG-58-9.6-98)

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY OF LONDON. SERIES A (GB)

8029J "High-Frequency Refraction and Diffraction in General Media," D. S. Jones, 255, 341-87 (Feb 63). (SB-63-5365)

PHYSICA (NETHERLANDS)

8030J "Resonant Behaviour of a Cylindrical Column of Plasma in Free Space with and without Steady Magnetic Fields," A. M. Messiaen and P. E. Vandenplas, 28, 537-52 (Jun 62). (I-62-9628)

8031J "Theory of Transverse Waves in Vlasov-Plasmas. III. Reflection of Electromagnetic Waves by a Plasma Half-Space," B. U. Felderhof, 29, 662-74 (Jun 63). (SA-63-19253; I-A63-20926)

8032J "Nonlinear Effects in the Reflection and Refraction on a Cold Magnetoplasma," F. W. Sluijter, 30, 1817-32 (Oct 64). (SA-65-3170; I-A65-15782)

PHYSICAL REVIEW

8033J "Scattering of Electromagnetic Plane Waves from Inhomogeneous Spherically Symmetric Objects," P. J. Wyatt, 127, 1837-43 (Sep 62). (SA-62-20153)

8034J "Sommerfeld-Runge Law in 3 and 4 Dimensions," H. Poeverlein, 128, 956 (Oct 62).

8035J "Scattering of Electromagnetic Waves in Saxon-Schiff Theory," H. Uberall, 128, 2429-34 (Dec 62). (SA-63-5846)

8036J "Scattering, Absorption, and Emission of Light by Thin Metal Wires," B. Agdur, G. Boling, F. Sellberg, and Y. Ohman, 130, 996-1001 (May 63). (I-A63-17811)

8037J "Backscatter from Inhomogeneous Media," P. J. Lynch, 130, 1235-43 (May 63). (SA-63-11676)

PHYSICAL REVIEW (CONT.)

8038J "Theorem on Electromagnetic Backscatter," R. J. Wagner and P. J. Lynch, 131, 21-23 (Jul 63). (SA-63-17055; I-A63-18857)

8039J "Variational Principles for Electromagnetic Potential Scattering," R. J. Wagner, 131, 423-34 (Jul 63). (SA-63-17056; I-A63-18870)

8040J "Transmission of Electromagnetic Waves Through Plasma Slabs," P. M. Platzman and S. J. Buchsbaum, 132, 2-9 (Oct 63). (SA-64-517; I-A63-24880)

8041J "Influence of Collisions on Scattering of Electromagnetic Waves by Plasma Fluctuations," A. Ron, J. Dawson, and C. Oberman, 132, 497-98 (Oct 63). (SA-64-560; I-A64-10186)

8042J "Bistatic Scattering from a Class of Lossy Dielectric Spheres with Surface Impedance Boundary Conditions," R. J. Garbacz, 133, A14-A16 (Jan 64). (SA-64-8941; I-A64-13525)

8043J "Incoherent Scattering of Radiation by Plasmas. I - Quantum Mechanical Calculation of Scattering Cross Sections," D. F. DuBois and V. Gilinsky, 133, A1308-A1316 (Mar 64). (I-A64-14961)

8044J "Incoherent Scattering of Radiation by Plasmas. II - Effect of Coulomb Collisions on Classical Plasmas," D. F. DuBois and V. Gilinsky, 133, A1317-A1322 (Mar 64). (I-A64-14962)

8045J "Perturbation Approach to the Diffraction of Electromagnetic Waves by Arbitrarily Shaped Dielectric Obstacles," C. Yeh, 135, A1193-A1201 (Aug 64). (SA-64-27645; I-A64-24544)

8046J "Scattering of a High-Intensity, Low-Frequency Electromagnetic Wave by an Unbound Electron," Z. Fried and J. H. Eberly, 136, B871-B887 (Nov 64). (SA-65-4960)

PHYSICS OF FLUIDS

8047J "Source and Reflection Problems in Magnetoionic Media," W. C. Meecham, 4, 1517-24 (Dec 61). (I-62-2558)

8048J "Scattering of Electromagnetic Waves by a Nonequilibrium Plasma," M. N. Rosenbluth and N. Rostoker, 5, 776-88 (Jul 62). (SB-62-10915)

8049J "Microwave Scattering from Unstable Plasma Waves," W. E. Drummond, 5, 1133-34 (Sep 62). (SB-63-3195; I-62-11460)

8050J "Incoherent Scatter from a Hot Plasma," R. A. Pappert, 6, 1452-57 (Oct 63). (SA-64-521; I-A63-24524)

8051J "Scattering of Electromagnetic Waves by a Plasma Cylinder," J. A. Fejer, 7, 439-45 (Mar 64). (SA-64-14667; I-A64-15614)

8052J "Analysis of Electromagnetic Wave Propagation Through Magnetoactive Plasmas," R. R. Gold, 7, 446-54 (Mar 64). (SA-64-14658; I-A64-15615)

PLANETARY AND SPACE SCIENCE (GB)

8053J "Artificial Electron Clouds, Pt. 1, Summary Report on the Creation of Artificial Electron Clouds in the Upper Atmosphere," F. F. Marmo, L. M. Aschenbrand, and J. Pressman, 1, 227-37 (Aug 59). (MG-60-11H-105)

8054J "Artificial Electron Clouds: Part 4.," J. Pressman, F. F. Marmo, and L. M. Aschenbrand, 2, 17-25 (Oct 59). (ET-60-2732)

PLANETARY AND SPACE SCIENCE (GB) (CONT.)

8055J "Artificial Electron Clouds: Pt. 6, Low Altitude Study, Release of Cesium at 69, 82, and 91 km," J. Pressman, F. F. Marmo, and L. M. Aschenbrand, 2, 228-37 (Aug 60). (ET-60-3841)

8056J "Radar Echoes Obtained from Earth Satellites 1957 Alpha and 1957 Beta," W. E. Jaye, R. B. Dyce, and R. L. Leadabrand, 5, 50-58 (Jan 61). (SA-61-9302; MG-62-13.5-86; I-61-2790; ET-61-1163)

8057J "Investigation of Auroral Echoes, II.," L. Harang and J. Troim, 5, 105-08 (Jun 61). (SA-62-4679; MG-62-13.9-221; I-61-5506; ET-61-2983)

8058J "Interaction of a Non-Uniform Plasma with Microwave Radiation," M. M. Klein, H. D. Greyber, J. I. F. King, and K. A. Brueckner, 6, 105-15 (Jun 61). (I-62-174)

8059J "On the Change in Radar Cross-Section of a Spherical Satellite Caused by a Plasma Sheath," C. L. Dolph and H. Weil, 6, 123-32 (Jun 61). (I-62-987)

8060J "Echo Area of a Plasma-Coated Sphere," L. Peters, Jr., and R. B. Green, 6, 133-41 (Jun 61). (SA-62-3170; I-62-983)

8061J "Reflection Mechanisms for Radio Aurora," P. A. Forsyth, 10, 179-86 (1963). (I-A63-13040)

8062J "Ionospheric Backscatter Observations," J. V. Evans and M. Loewenthal, 12, 915-44 (Oct 64). (SA-65-4503; I-A65-10081)

PRACE PRZEMYSLOWEGO INSTYTUTU TELEKOMUNIKACJI (POLAND)

8063J "Methods of Calculating the Coefficient of Reflection from Parallel-Layer System on a Perfectly Reflecting Base," M. Suski, No. 21, 1-10 (1957). (SB-58-1349)

8064J "Method for the Calculation of Parameters of a Non-Reflecting Parallel-Plate Dielectric Layer," M. Suski, No. 24, 1-14 (1958). (SB-59-6490)

8065J "Broadband Absorption Dielectrics. I. Theoretical Considerations," L. Badian, No. 34, 9-27 (1961). (SB-62-6786)

8066J "Broadband Absorption Dielectrics. II. Experimental Work," L. Badian, No. 34, 29-46 (1961). (SB-62-6787)

PRACE USTAVU RADIOTECHNIKY A ELEKTRONIKY (CZECHOSLOVAKIA)

8067J "The Depolarisation of Electromagnetic Waves Scattered from Rough Surface," P. Beckmann, No. 12, 28 pp (1961). (SB-62-5311)

8068J "The Depolarisation of Electromagnetic Waves Back-Scattered from Certain Bodies," B. Chytil, No. 17, 38 pp (1961). (SB-62-5312)

8069J "The Statistical Distribution of the Amplitude and Phase of a Multiply Scattered Field," P. Beckmann, No. 18, 41 pp (1961). (SB-62-8231)

8070J "The Scattering of Waves by a Periodic Surface," P. Beckmann, No. 18, 16 pp (1961). (SA-62-7760)

8071J "The Depolarisation of Electromagnetic Waves by Inclined Planes," P. Beckmann, No. 19, 17 pp (1961). (SB-62-8221)

8072J "The Depolarization by Randomly Spaced Scatterers," B. Chytil, No. 20, 32 pp (1961). (SB-62-8235)

PRACE USTAVU RADIOTECHNIKY A ELEKTRONIKY (CZECHOSLOVAKIA) (CONT.)

8073J "Polarization-Dependent Scattering Cross-Sections," B. Chytil, No. 21, 13 pp (1961). (SB-62-8233)

PRIKLADNAYA MATEMATIKA I MEKHANIKA (USSR) [Cover-to-Cover Translation]

8074J "On the Theory of Diffraction of Plane Elastic and Electromagnetic Waves," I. G. Filippov, 27, No. 6, 1026-36 (1963). (SA-64-24290; I-A64-14216; I-A64-19317)

PROCEEDINGS OF THE CAMBRIDGE PHILOSOPHICAL SOCIETY (GB)

8075J "An Approximate Treatment of High-Frequency Scattering," D. S. Jones and G. B. Whitham, 53, Pt. 3, 691-701 (Jul 57). (SA-58-6079)

8076J "Comments on the Treatment of Diffraction of Plane Waves: Addendum to 'The Edge Conditions and Field Representation Theorems in the Theory of Electromagnetic Diffraction,'" A. E. Heins and S. Silver, 54, Pt. 1, 131-33 (Jan 58). (SA-58-6080; ET-58-3061)

8077J "Diffraction by a Wide Slit and Complementary Strip," R. F. Millar, 54, Pt. 4, 479-511 (Oct 58). (SA-59-479; SA-59-480; ET-59-411)

8078J "Variational Principles in High-Frequency Scattering," R. D. Kodis, 54, Pt. 4, 512-29 (Oct 58). (SA-59-1613; ET-59-412)

8079J "Scattering of Plane Waves by Locally Homogeneous Dielectric Noise," R. A. Silverman, 54, Pt. 4, 530-37 (Oct 58). (ET-59-415)

8080J "Diffraction by an Imperfectly Conducting Right-Angled Wedge," W. E. Williams, 55, Pt. 2, 195-209 (Apr 59). (SA-59-4849)

8081J "The Low-Frequency Scattering by a Perfectly Conducting Strip," D. S. Jones and B. Noble, 57, Pt. 2, 364-66 (Apr 61). (SA-61-19030; ET-62-81)

8082J "Electromagnetic Diffraction by a Circular Disk," W. E. Williams, 58, Pt. 4, 625-30 (Oct 62). (SA-62-22336)

8083J "Scalar Diffraction by Prolate Spheroids Whose Eccentricities Are Almost One," R. F. Goodrich and N. D. Kazarinoff, 59, Pt. 1, 167-83 (Jan 63). (SA-63-4274; I-A63-13214)

8084J "Diffraction by a Spherical Cap," D. P. Thomas, 59, 197-209 (1963).

8085J "Electromagnetic Diffraction by Two Coaxial Discs," D. P. Thomas, 60, Pt. 3, 621-36 (1964). (SA-64-27648)

PROCEEDINGS OF THE IEEE

8086J "Requirements of a Coherent Laser Pulse-Doppler Radar," G. Biernson and R. F. Lucy, 51, 202-13 (Jan 63). (SB-63-5418)

8087J "Radar Cross-Section of a Cone Sphere," K. M. Siegel, E. M. Kennaugh, and D. L. Moffatt, 51, 231-32 (Jan 63). (SB-63-7791)

8088J "Low-Frequency Radar Cross-Section Computations," K. M. Siegel, 51, 232-33 (Jan 63). (SB-63-7792)

8089J "A Note on the Ricatti Differential Equation," H. Volland, 51, 954 (Jun 63). (SB-63-12292)

8090J "Experimental Measurements of the Radar Cross Section of a Cone Sphere," W. E. Blore, 51, 1263-64 (Sep 63). (SB-63-15922; I-A63-24837)

PROCEEDINGS OF THE IEEE (CONT.)

8091J "A Reciprocity Theorem for the Interaction of Electromagnetic Plane Waves with a One-Dimensional Inhomogeneous Slab," C. T. Swift, 51, 1268-69 (Sep 63). (SB-64-700; I-A63-24840)

8092J "Experimental Verification of Scattering Coefficients for Metal Spheres," W. E. Blore, 51, 1270-71 (Sep 63). (SB-64-309; I-A63-24842)

8093J "A Free-Space Method of Measuring Radar Cross Section in the Laboratory," P. C. Fritsch, 51, 1271-72 (Sep 63). (SA-64-3144; I-A63-24844)

8094J "Physical Nature of the Doppler-Frequency Spectrum from a Rotating Planet and Its Effect on Detection," E. O. Willoughby, 52, 80-81 (Jan 64). [Comments: ibid., 52, 741 (Jun 64)]. (SB-64-5317; I-A64-19959)

8095J "Audio-Frequency Characterization of Radar-Absorbing Material," L. C. Lynnworth, 52, 98-99 (Jan 64). (SB-64-6586; I-A64-13678)

8096J "Fabrication of Lightweight Targets for Radar Measurements," S. Abrams, J. DeLuca, K. Weil, and I. Weissman, 52, 436 (Apr 64). (SB-64-10245; I-A64-18991)

8097J "Measured Physical Characteristics of the West Ford Belt," F. E. Heart, D. Karp, A. A. Mathiasen, et al., 52, 519-33 (May 64). (SB-64-15957)

8098J "RF Characteristics of Thin Dipoles," C. L. Mack, Jr., and B. Reiffen, 52, 533-42 (May 64). [Comments: R. F. Harrington, ibid., 52, 1736-37 (Dec 64)]. (SA-64-30052; I-A64-19583)

8099J "The West Ford Belt as a Communications Medium," I. L. Lebow, P. R. Drouilhet, Jr., N. L. Daggett, et al., 52, 543-63 (May 64). (SB-64-15958; I-A64-19584)

8100J "Effects of the West Ford Belt on Astronomical Observations," D. C. MacLellan, W. E. Morrow, Jr., and I. I. Shapiro, 52, 564-70 (May 64). (SB-64-15994)

8101J "The West Ford Payload," P. Waldron, D. C. MacLellan, and M. C. Crocker, 52, 571-76 (May 64). (I-A64-19586)

8102J "A New Method of Measuring Small Radar Cross Sections by Digital Vector-Field Subtraction," P. C. Fritsch and F. E. Heart, 52, 628-29 (May 64). (SB-65-1374)

8103J "Experimental Determination of the Absolute Phase Path of Radio Waves Reflected from the Ionosphere at Normal Incidence," N. N. Rao, H. M. Swarm, and A. E. Harrison, 52, 858-59 (Jul 64). (I-A64-24732)

8104J "Axial Echo Area of the Prolate Spheroid," E. M. Kennaugh and D. L. Moffatt, 52, 1252-53 (Oct 64). (SB-65-6566)

8105J "Comment on Microwave Reflection by Non-Uniform Plasmas with Exponential Electron Distribution," C. R. Mullin and E. D. Shane, 52, 1272-73 (Oct 64). (SA-65-11714)

8106J "High Frequency Back Scatter from the Earth Measured at 1000 km Altitude," R. C. Chia, A. K. Fung, and R. K. Moore, 52, 1384-85 (Nov 64). (SB-65-8568; I-A65-13717)

8107J "A $\lambda/4$ and $\lambda/2$ Shift Method for Elimination of Unwanted Wall-Echoes in Radar-Anechoic Chambers," J. H. Halberstein and P. C. Fritsch, 52, 1743-44 (Dec 64).

PROCEEDINGS OF THE INDIAN ACADEMY OF SCIENCES, SECTION A

8108J "F-Scatter and Cosmic Radio Noise on 25 Mc/s at Ahmedabad," J. S. Shirke, 56, No. 4, 165-70 (Oct 62). (SB-63-4392)

PROCEEDINGS OF THE INSTITUTION OF ELECTRICAL ENGINEERS (GB)

8109J "The Diffraction of an Electromagnetic Wave by a Circular Aperture," R. F. Millar, 104C, 87-95 (Mar 57). [Also published as Monograph 196R (Sep 56)]. (SB-57-1626; ET-57-2425)

8110J "The Diffraction of an Electromagnetic Wave by a Large Aperture," R. F. Millar, 104C, 240-50 (Sep 57). [Also published as Monograph 213R (Dec 56)]. (SA-57-1468; ET-57-3834)

8111J "The Attenuation of Radio Waves Reflected from the E Region of the Ionosphere," R. W. Meadows, 105B, 22-26 (Jan 58). (ET-58-1238)

8112J "The Effect of Fading on the Accuracy of Measurement of Ionospheric Absorption," R. W. Meadows and A. J. G. Moorat, 105B, 27-32 (Jan 58). (ET-58-1240)

8113J "The Use of Dielectric Materials to Enhance the Reflectivity of a Surface at Microwave Frequencies," G. B. Walker and J. T. Hyman, 105B, 73-76 (Jan 58). (SB-58-778)

8114J "Radar Observations of the Russian Earth Satellites and Carrier Rocket," J. Davis, J. V. Evans, S. Evans, et al., 105B, 105-07 (Mar 58). (ET-58-1720)

8115J "Radio Observations on the Russian Satellites. Observations at the Royal Radar Establishment," J. S. Hey, 105B, 107-08 (Mar 58).

8116J "A Survey of Harbour Approach Aids," A. L. P. Milwright, 105B, Supplement No. 9, 351-57 (1958). (SB-58-2277)

8117J "Phase-Coherent Back-Scatter of Radio Waves at the Surface of the Sea," E. Sofaer, 105B, 383-94 (Jul 58). (MG-61-12M-811; ET-58-3612)

8118J "Theory of Reflections from the Rodded-Type Artificial Dielectric," A. Carne and J. Brown, 106B, 107-15 (1959). (SB-59-542)

8119J "Optical Techniques at Microwave Frequencies," A. F. Harvey, 106B, 141-57 (Mar 59). (SB-59-3174)

8120J "Microwave Magnetic-Field Measurements by a Modulated Scattering Technique," B. J. Strait and D. K. Cheng, 109B, 33-40 (Jan 62). (SB-62-3829)

8121J "Passive Bistatic Radar Enhancement Devices," L. Peters, 109C, 1-10 (Mar 62). [Also appeared as Monograph 455E (Jul 61)]. (SB-61-5386)

8122J "Reflection and Transmission of an Electromagnetic Wave by a Gaseous Plasma," G. R. Nicoll and J. Basu, 109C, 335 (1962). [Also appeared as Monograph 498E].

8123J "Theoretical Characteristics of Radiation Reflected Obliquely from a Rough Conducting Surface," R. H. Clarke, 110, 91-100 (Jan 63). (SB-63-4920)

8124J "Some Properties of Van Atta Arrays and the Use of 2-Way Amplification in the Delay Paths," D. E. N. Davies, 110, 507-12 (Mar 63).

8125J "Measurements on Radiation Reflected Obliquely from a Rough Surface," R. H. Clarke, 110, 1921-27 (Nov 63). (SB-64-1738)

8126J "Polarization of Radar Echoes, Including Aircraft, Precipitation and Terrain," H. Gent, I. M. Hunter, and N. P. Robinson, 110, 2139-48 (Dec 63). (SB-64-2694)

8127J "Tracking Radars for Complex Targets," L. Peters, Jr., and F. C. Weimer, 110, 2149-62 (Dec 63). (SB-64-2695)

8128J "Propagation and Diffraction in Uniaxially Anisotropic Regions. I. Theory," L. B. Felsen, 111, 445-53 (Mar 64). (SA-64-14883; I-A64-18240)

PROCEEDINGS OF THE INSTITUTION OF ELECTRICAL ENGINEERS (GB) (CONT.)

8129J "Propagation and Diffraction in Uniaxially Anisotropic Regions. II. Applications," L. B. Felsen, 111, 454-64 (Mar 64). (SA-64-14884; I-A64-18241)

8130J "Theory of Loaded Scatterers," R. F. Harrington, 111, 617-23 (Apr 64). (SB-64-8735; I-A64-18250)

8131J "Scattering by a Sphere," T. B. A. Senior and R. F. Goodrich, 111, 907-16 (May 64). (SA-64-21656; I-A64-20270)

8132J "Diffraction Theory and Polarisation," J. R. Blakey, 111, 1283-84 (Jul 64). (SB-64-15286)

8133J "Effect of Weather on Performance of an 8 mm Radar," O. Nourse and S. G. Nicholls, 111, 1523-33 (Sep 64). (SB-64-14327)

8134J "Determination of Antenna Parameters by Scattering Cross-Section Measurements," R. J. Garbacz, 111, 1679-86 (Oct 64). (SB-64-15914; I-A64-27771)

PROCEEDINGS OF THE IRE

8135J "A Theory on Radar Reflections from the Lower Atmosphere," W. E. Gordon, 37, 41-43 (Jan 49). (MG-57-8I-59)

8136J "A Phenomenological Theory of Radar Echoes from Meteors," D. W. R. McKinley and P. M. Millman, 37, 364-75 (Apr 49). (MG-57-8H-12)

8137J "Radar Reflections in the Lower Atmosphere," A. B. Crawford, 37, 404-05 (Apr 49). (MG-57-8I-55)

8138J "A Theory of Radio Scattering in the Troposphere," H. G. Booker and W. E. Gordon, 38, 401-12 (Apr 50).

8139J "The Patterns of Antennas Located Near Cylinders of Elliptical Cross Section," G. Sinclair, 39, 660-68 (Jun 51).

8140J "On the Mechanisms of Radar Sea Clutter," M. Katzin, 45, 44-54 (Jan 57). (SB-57-3174; ET-57-1090)

8141J "Back-Scattering Characteristics of the Sea in the Region from 10 to 50 kMc/s," J. C. Wiltse, S. P. Schlesinger, and C. M. Johnson, 45, 220-28 (Feb 57). (SB-57-3175; ET-57-1574)

8142J "Radar Terrain Return at Near-Vertical Incidence," R. K. Moore and C. S. Williams, Jr., 45, 228-38 (Feb 57). (SB-57-3176; ET-57-1457)

8143J "Reflection at a Sharply-Bounded Ionosphere," I. W. Yabroff, 45, 750-53 (Jun 57). (ET-57-2754)

8144J "Back-Scattering from Water and Land at Centimeter and Millimeter Wavelengths," C. R. Grant and B. S. Yaplee, 45, 976-82 (Jul 57). (SB-57-5900; ET-57-3277)

8145J "Radar Echoes from Overdense Meteor Trails Under Conditions of Severe Diffusion," G. S. Hawkins, 45, 1290-91 (Sep 57). (MG-58-9H-31; ET-57-3850)

8146J "Radio and Radar Tracking of the Russian Earth Satellite," A. M. Peterson, et al., 45, 1553-55 (1957).

8147J "Lunar Radio Echoes," J. H. Trexler, 46, 286-92 (Jan 58). (SA-58-1448; MG-61-12K-97)

8148J "Radar Echoes from the Moon at a Wavelength of 10 cm," B. S. Yaplee, R. H. Bruton, K. J. Craig, and N. G. Roman, 46, 293-97 (Jan 58). (SB-58-2381; MG-60-11H-163; MG-61-12K-98)

8149J "Measurement of the Radar Cross-Section of a Man," F. V. Schultz, R. C. Burgener, and S. King, 46, 476-81 (Feb 58). (SB-58-2283; ET-58-1437)

8150J "Detection of Sputniks I and II by C. W. Reflection," J. D. Kraus, 46, 611-12 (Mar 58). (SB-58-3841; ET-58-1724)

8151J "The Last Days of Sputnik I," J. D. Kraus, 46, 612-14 (Mar 58). (SB-58-3842; ET-58-1725)

8152J "Observations of the U. S. Satellites Explorers I and III by C. W. Reflection," J. D. Kraus, R. C. Higgy, and J. S. Albus, 46, 1534 (Aug 58). (ET-58-3447)

8153J "Radio Reflections from Satellite-Produced Ion Columns," C. D. Hendricks, Jr., G. W. Swenson, Jr., and R. A. Schorn, 46, 1763 (Oct 58). (SB-59-1194; ET-59-121)

8154J "Incoherent Scattering of Radio Waves by Free Electrons with Applications to Space Exploration by Radar," W. E. Gordon, 46, 1824-29 (Nov 58). (SB-59-554; ET-59-451)

8155J "Meteors in the Ionosphere," L. A. Manning and V. R. Eshleman, 47, 186-99 (Feb 59). (ET-59-1526)

8156J "Auroral Phenomena," E. N. Parker, 47, 239-44 (Feb 59). (ET-59-1568)

8157J "Auroral Ionization and Magnetic Disturbances," B. Nichols, 47, 245-54 (Feb 59). (ET-59-1570)

8158J "Radiation Measurements at Radio Frequencies: A Survey of Current Techniques," W. A. Cummings, 47, 705-35 (May 59).

8159J "Phenomena of Scintillation Noise in Radar Tracking Systems," J. H. Dunn, D. D. Howard, and A. M. King, 47, 855-63 (May 59). (SB-59-4919; ET-59-2609)

8160J "Radio Reflections from Satellite-Produced Ionization," C. R. Roberts, P. H. Kirchner, and D. W. Bray, 47, 1156-57 (Jun 59). (SB-59-6770; ET-59-2963)

8161J "Related Experiments with Sound Waves and Electromagnetic Waves," W. E. Kock, 47, 1192-1201 (Jul 59). (SB-59-6489)

8162J "A Possible Mechanism for Radiation and Reflection from Ionized Gas Clouds," W. C. Hoffman, 47, 1274-75 (Jul 59). (SB-59-7599)

8163J "The Use of a Passive Spherical Satellite for Communication and Propagation Experiments," T. H. Vea, J. B. Day, and R. T. Smith, 48, 620-24 (Apr 60). [Errors are discussed in: E. M. Kennaugh, S. P. Morgan, and H. Weil, ibid., 1781 (Oct 60), and N. A. Logan, ibid., 1782 (Oct 60)]. (SB-60-5777; SB-61-2400; SB-61-4222)

8164J "The Satellite Ionization Phenomenon," J. D. Kraus, R. C. Higgy, and W. R. Crone, 48, 672-78 (Apr 60). (SB-60-5817)

8165J "Radio Frequency Scattering from the Surface of the Moon," R. L. Leadabrand, R. B. Dyce, A. Fredriksen, et al., 48, 932-33 (May 60). (SA-60-16526; ET-60-2713)

8166J "Measurements of Lunar Reflectivity Using the Millstone Radar," G. H. Pettengil 48, 933-34 (May 60). (SB-60-6445; ET-60-2714)

8167J "Lunar Echoes Received on Spaced Receivers at 106.1 Mc," R. B. Dyce and R. A. Hill, 48, 934-35 (May 60). (SB-60-6446; ET-60-2715)

PROCEEDINGS OF THE IRE (CONT.)

8168J "Generating a Rotating Polarization," P. J. Allen, 48, 941 (May 60).

8169J "Experimental Proof of Focusing at the Skip Distance by Backscatter Records," K. Bibl, 48, 956-57 (May 60). [Comments: H. F. Bates, R. D. Hunsucker, L. Owren, and K. Bibl, ibid., 49, 369 (Jan 61)]. (SB-60-6405; ET-61-1292)

8170J "Radar Target Classification by Polarization Properties," J. R. Copeland, 48, 1290-96 (Jul 60). (SB-60-6433)

8171J "High-Frequency Radar Echoes from the Sun," M. H. Cohen, 48, 1479 (Aug 60). (SB-61-428; MG-62-13.6-94)

8172J "Forward Scattering by Coated Objects Illuminated by Short-Wavelength Radar," R. E. Hiatt, K. M. Siegel, and H. Weil, 48, 1630-35 (Sep 60). [Comments: J. Fisch; K. M. Siegel and R. E. Hiatt, ibid., 49, 1951 (Dec 61)]. (SB-60-8307; SB-63-15921; I-61-253; ET-60-4255; ET-62-899)

8173J "The Ineffectiveness of Absorbing Coatings on Conducting Objects Illuminated by Long Wavelength Radar," R. E. Hiatt, K. M. Siegel, and H. Weil, 48, 1636-42 (Sep 60). (SB-60-8308; I-61-252; ET-60-4256)

8174J "A Study of Surface Roughness and Its Effect on the Back-Scattering Cross-Section of Spheres," R. E. Hiatt, T. B. A. Senior, and V. H. Weston, 48, 2008-16 (Dec 60). (SA-61-7150; ET-61-834)

8175J "Volume Density of Radio Echoes from Meteor Trails," N. Carrara, P. F. Checcacci, and L. Ronchi, 48, 2031-32 (Dec 60). (MG-62-13.8-195)

8176J "The Scattering of Short Electromagnetic Pulses by a Conducting Sphere," E. M. Kennaugh, 49, 380 (Jan 61). (SB-61-2712)

8177J "Technique for Amplitude Modulating a Van Atta Radar Reflector," L. H. Bauer, 49, 634 (Mar 61). (ET-61-1865)

8178J "The Operation of Radio Altimeters Over Snow-Covered Ground or Ice," W. R. Piggott, 49, 965 (May 61). [Comments: A. H. Waite, ibid., 49, 1449 (Sep 61)]. (SB-61-6449; SB-62-10068; ET-61-2612)

8179J "Sideband Correlation of Lunar and Echo Satellite Reflection Signals in the 900-Mc Range," R. E. Anderson, 49, 1081-82 (Jun 61). (SB-62-4640; ET-61-2953)

8180J "An Experimental Study of Bistatic Scattering from Some Small, Absorber-Coated, Metal Shapes," R. J. Garbacz and D. L. Moffatt, 49, 1184-92 (Jul 61). (SB-61-6453; I-61-7245; ET-61-3347)

8181J "Radar Scattering Cross Section Applied to Moon Return," H. S. Hayre, 49, 1433 (Sep 61). (SB-62-6129; ET-61-4155)

8182J "Technique for Amplitude Modulating a Van Atta Radar Reflector," W. F. Bahret, 49, 1692 (Nov 61). (SB-63-15927)

8183J "RF Reflectance of Plasma Sheaths," L. S. Taylor, 49, 1831-36 (Dec 61). (I-62-2554)

8184J "The Radar Cross Section of the Moon," T. B. A. Senior and K. M. Siegel, 49, 1944-45 (Dec 61). (SB-62-10151; ET-62-849)

8185J "Doppler Studies of the Ionosphere with Vertical Incidence," K. Davies, 50, 94-95 (Jan 62). [Correction: ibid., 50, 1544 (Jun 62)]. (SB-62-8255)

8186J "On the Axial Echo Area of the Cone-Sphere Shape," E. M. Kennaugh and D. L. Moffatt, 50, 199 (Feb 62). (SB-63-1843; ET-62-1509)

PROCEEDINGS OF THE IRE (CONT.)

8187J "Roughness and Radar Return," H. S. Hayre, 50, 223-24 (Feb 62). (SB-62-10138; ET-62-1580)

8188J "Upwind-Downwind Ratio of Radar Return Calculated from Facet Size Statistics of a Wind-Disturbed Water Surface," A. H. Schooley, 50, 456-61 (Apr 62). (SB-62-10150; ET-62-2329)

8189J "Gross Errors in Height Indication from Pulsed Radar Altimeters Operating Over Thick Ice or Snow," A. H. Waite and S. J. Schmidt, 50, 1515-20 (Jun 62). (ET-62-3040)

8190J "Project Luna See," L. D. Smullin and G. Fiocco, 50, 1703-04 (Jul 62). (SA-62-22015)

8191J "Electromagnetic Scattering from Radially Inhomogeneous Spheres," R. J. Garbacz, 50, 1837-38 (Aug 62). (SA-62-22339; ET-62-3585)

8192J "Scatterer Echo Area Enhancement," J. L. Ryerson, 50, 1979-80 (Sep 62). (SB-63-2231)

8193J "A Table of Solutions of Riccati's Equations," I. Sugai, 50, 2124-26 (Oct 62). (SB-63-2468)

PROCEEDINGS OF THE NATIONAL INSTITUTE OF SCIENCES OF INDIA, PART A

8194J "High-Frequency Diffraction of Plane Waves by an Infinite Slit: Parts 1 and 2," S. R. Seshadri, 25, 301-36 (Nov 59). (SA-61-240; ET-60-3796)

8195J "A Note on the Back-Scattering by an Infinite Strip," S. R. Seshadri, 26, 604-08 (Nov 60). (SA-61-16570; ET-61-3345)

8196J "A Note on the Back-Scattering of a Circular Disk," S. R. Seshadri, 26, 609-16 (Nov 60). (SA-61-16571; ET-61-3342)

8197J "Diffraction of a Plane Wave by a Unidirectionally Conducting Half-Plane," S. R. Seshadri, 27, 1-10 (Jan 61). (SA-61-16572; ET-61-3724)

8198J "Conditions of Reflection of Radio Waves from the Ionosphere and Their Polarization Characteristics for Zero Collisional Frequency," S. K. Banerjee and S. R. Khastgir, 29, 370-77 (May 63). (SA-64-8953)

PROCEEDINGS OF THE PHYSICAL SOCIETY (GB)

8199J "Radar Echoes from Inter-Stroke Processes in Lightning," F. J. Hewitt, 70, No. 454B, 961-79 (Oct 57). (SA-58-839; MG-58-9H-32; ET-58-782)

8200J "The Scattering of Radio Waves by the Moon," J. V. Evans, 70, Pt. 12, 1105-12 (Dec 57). (SA-58-855; ET-58-1402)

8201J "Anomalous Variation of Total Absorption of Radio Waves Reflected from the F_2 Region of the Ionosphere Around Midday," S. K. Sharma, 71, No. 462, 1007-10 (Jun 58). (ET-58-3817)

8202J "Electromagnetic Scattering by Thin Conducting Plates at Glancing Incidence," J. S. Hey and T. B. A. Senior, 72, No. 468, 981-95 (Dec 58). (ET-59-772)

8203J "Radio Observations of the Lunar Surface," J. K. Hargreaves, 73, No. 471, 536-37 (Mar 59). (ET-59-1863)

8204J "Diffraction by an Irregular Screen of Limited Extent," B. H. Briggs, 77, No. 494, 305-17 (Feb 61). (SA-61-6962; ET-61-1474)

PROCEEDINGS OF THE PHYSICAL SOCIETY (GB) (CONT.)

8205J "Diffraction by Finite Irregular Objects," R. P. Mercier, 77, Pt. 2, 318-27 (Feb 61). (SA-61-6963; ET-61-1475)

8206J "Radio Wave Scattering from the Lunar Surface," V. A. Hughes, 78, Pt. 5(ii), No. 504, 988-97 (Nov 61). (SA-62-1009; ET-62-848)

8207J "Diffraction Theory Applied to Radio Wave Scattering from the Lunar Surface," V. A. Hughes, 80, Pt. 5, 1117-27 (Nov 62). (SA-63-1512)

8208J "A Note on the Theory of Moon Echoes," E. N. Bramley, 80, Pt. 5, 1128-32 (Nov 62). (SA-63-1513)

8209J "The Physical Basis of the Research Programmes at Jodrell Bank," A. C. B. Lovell, 81, Pt. 3, 385-411 (Mar 63). (SA-63-11587)

8210J "An Experimental Investigation of Back Scattering of Radio Waves from the Equatorial Electrojet," R. L. Closs, 82, Pt. 5, 664-68 (Nov 63). [Comments: R. Cohen and D. T. Farley, Jr., ibid., 84, Pt. 4, 619-21 (Oct 64)]. (SA-64-4792; SA-65-1942)

PROCEEDINGS OF THE ROYAL SOCIETY OF LONDON. SERIES A (GB)

8211J "High-Frequency Scattering of Electromagnetic Waves," D. S. Jones, 240, 206-13 (May 57). (SA-57-8732; ET-57-3835)

8212J "The Reflexion of Radio Waves from a Stratified Ionosphere Modified by Weak Irregularities," M. L. V. Pitteway, 246, 556-69 (Aug 58). (ET-59-2250)

8213J "Diffraction of an E-Polarized Plane Wave by an Imperfectly Conducting Wedge," W. E. Williams, 252, 376-93 (Sep 59). (SA-60-3856)

8214J "The Half-Plane Diffraction Problem for Harmonic Time Dependence," A. P. Burger, 252, 411-17 (Sep 59). (SA-60-3435)

8215J "The Diffraction and Refraction of Pulses," V. M. Papadopoulos, 252, 520-37 (Oct 59). (SA-60-8752)

8216J "Diffraction of a Pulse by a Resistive Half-Plane. I. Normal Incidence," V. M. Papadopoulos, 255, 538-49 (May 60). (SA-60-19301; ET-61-503)

8217J "Diffraction of a Pulse by a Resistive Half-Plane. II. Oblique Incidence," V. M. Papadopoulos, 255, 550-57 (May 60). (SA-60-19302; ET-61-503)

8218J "Auroral Radio Echoes at Halley Bay," D. P. Harrison, 256, 229-34 (Jun 60). (ET-61-570)

8219J "Diffraction of an Electromagnetic Plane Wave by a Metallic Sheet," W. E. Williams, 257, 413-19 (Sep 60). (SA-60-19929; ET-61-507)

8220J "A Theory of Incoherent Scattering of Radio Waves by a Plasma," J. P. Dougherty and D. T. Farley, 259, 79-99 (Nov 60). (SA-60-19931; ET-61-2345)

8221J "The Numerical Solution of Differential Equations Governing the Reflexion of Long Radio Waves from the Ionosphere. IV.," D. W. Barron, 260, 393-408 (Mar 61). (I-61-3286)

8222J "A Theory of Incoherent Scattering of Radio Waves by a Plasma. II. Scattering in a Magnetic Field," D. T. Farley, J. P. Dougherty, and D. W. Barron, 263, 238-58 (Sep 61). (SA-61-16314; ET-62-269)

8223J "On the Theory of the Diffraction of a Plane Wave by a Large Perfectly Conducting Circular Cylinder," P. C. Clemmow, 264, 235-45 (Nov 61). (SA-61-19026; I-62-474; ET-62-454)

PROCEEDINGS OF THE ROYAL SOCIETY OF LONDON. SERIES A (GB) (CONT.)

8224J "Diffraction of a Plane Wave by an Almost Circular Cylinder," P. C. Clemmow and V. H. Weston, 264, 246-68 (Nov 61). (SA-61-19027; I-62-475; ET-62-455)

8225J "Diffraction by a Disk," W. E. Williams, 267, 77-87 (Apr 62).

8226J "Diffraction by a Cylinder with a Variable Surface Impedance," L. B. Felsen and C. J. Marcinkowski, 267, 329-44 (May 62). (SA-62-11792)

PROCEEDINGS OF VIBRATION PROBLEMS (POLAND)

8227J "Scattering and Attenuation of Electromagnetic Waves in a Turbulent Medium," M. A. Krzywoblocki, 3, No. 4(13), 245-81 (1962). (SB-63-8636; I-A63-15369)

PROGRESS OF THEORETICAL PHYSICS (JAPAN)

8228J "On an Expression for the Total Cross Section," L. I. Schiff, 11, 288-90 (Mar 54).

PRZEGLAD TELEKOMUNIKACYJNY (POLAND)

8229J "Investigation of Radioechoes in Ionosphere and Exosphere," S. Manczarski, No. 12, 367-71 (1961). (SB-62-11359)

PUBLICATIONS OF THE ASTRONOMICAL SOCIETY OF JAPAN

8230J "On the Possibility of Receiving Radar Echoes from the Sun at High Frequencies," F. Moriyama, 16, 23-29 (1964). (I-A64-23779; I-A64-24340)

QUARTERLY OF APPLIED MATHEMATICS

8231J "Diffraction of a Dipole Field by a Unidirectionally Conducting Semi-Infinite Plane Screen," J. Radlow, 17, 113-27 (Jul 59). (SA-59-9878)

8232J "On the Diffraction of an Arbitrary Pulse by a Wedge or a Cone," L. Ting, 18, 89-92 (Apr 60). (SA-60-15144)

8233J "Diffraction of a Plane Wave by a Right-Angled Wedge Which Sustains Surface Waves on One Face," F. C. Karal, Jr., and S. N. Karp, 20, 97-106 (Jul 62). (SA-63-5847; I-62-9862; ET-62-4000)

8234J "Scattering from Random Linear Arrays With Closest Approach," Z. A. Melzak, 20, 151-59 (Jul 62). (SB-63-2230; I-62-9752)

8235J "Function-Theoretic Solution to a Class of Dual Integral Equations and an Application to Diffraction Theory," R. A. Schmeltzer and M. Lewin, 21, 269-83 (Jan 64). (I-A64-13832)

8236J "On the Solution of a Transcendental Equation Arising in the Theory of Scattering by a Dielectric Cylinder," W. Streifer and R. D. Kodis, 21, 285-98 (Jan 64). (SB-65-9616; I-A64-13833)

8237J "On the Scattering of Electromagnetic Waves by a Dielectric Cylinder," W. Streifer and R. D. Kodis, 22, 193-206 (Oct. 64). (SB-65-4930; I-A64-28477)

QUARTERLY JOURNAL OF MECHANICS AND APPLIED MATHEMATICS (GB)

8238J "The Diffraction of Electromagnetic Waves Around a Finite, Perfectly Conducting Cone," F. H. Northover, 15, Pt. 1, 1-9 (Feb 62). (ET-62-2965)

QUARTERLY JOURNAL OF THE ROYAL ASTRONOMICAL SOCIETY (GB)

8239J "Planetary Radar," J. H. Thomson, 4, 347-75 (Dec 63). (I-A64-15520)

QUARTERLY JOURNAL OF THE ROYAL METEOROLOGICAL SOCIETY (GB)

8240J "Radar Observations of Showers Suggesting a Coalescence Mechanism," P. J. Feteris and B. J. Mason, 82, 446-51 (Oct 56). (MG-57-8.2-65; ET-57-1767)

8241J "Radar Echoes from Atmospheric Inhomogeneities," R. F. Jones, 84, 437-42 (Oct 58). [Comments: W. G. Harper, R. F. Jones, ibid., 85, 435-36 (Oct 59)]. (SA-59-11642; MG-59-10.8-132; MG-60-11H-58; ET-59-819; ET-60-3882)

8242J "Radar Scatter by Large Hail," D. Atlas, W. G. Harper, F. H. Ludlam, and W. C. Macklin, 86, 468-82 (Oct 60). (SB-61-425; ET-61-1531)

8243J "Calculations of Mie Back-Scattering of Microwaves from Ice Spheres," B. M. Herman and L. J. Battan, 87, 223-30 (Apr 61). (SA-62-2478; MG-62-13.1-496)

8244J "Multi-Wavelength Radar Reflectivity of Hailstorms," D. Atlas and F. H. Ludlam, 87, 523-34 (Oct 61). (SA-62-2479)

8245J "Large-Sphere Limit of the Radar Back-Scattering Coefficient," J. E. McDonald, 88, 183-86 (Apr 62). (SA-62-11793)

8246J "The Radar Equation in Meteorology," C. D. Watkins, 89, 424-25 (Jul 63). (SA-64-4804)

RADIO AND ELECTRONIC ENGINEER (GB)

8247J "Phenomena During the Growth and Decay of Spread-F," M. S. V. G. Rao and B. R. Rao, 25, 445-48 (May 63). (I-A63-19303)

8248J "Method of Distinguishing Sea Targets from Clutter on a Civil Marine Radar," A. Harrison, 27, 261-75 (Apr 64). (SB-64-9085)

RADIOTEKHNIKA [KIEV] (USSR)

8249J "Plane Wave Incidence on the Interface of a Vacuum and an Inhomogeneous Absorbing Medium," E. A. Filatova, 7, 597-602 (Sep-Oct 64). (I-A65-15957)

RADIOTEKHNIKA [MOSCOW] (USSR) [Cover-to-Cover Translation]

8250J "Reflection of a Plane Wave at a Wire Mesh in the Case of Normal Polarization," V. G. Yampol'skii, 11, No. 11, 33-37 (Nov 56). (SB-57-3791; ET-58-1330)

8251J "Influence of a Dielectric Layer on the Reflecting Properties of a Nonsolid Reflector," V. G. Yampol'skii, 12, No. 2, 59-64 (Feb 57). (ET-57-3398)

8252J "The Reflection of a Plane Transversely Polarized Wave from a Rectangular Grid," L. N. Deryugin, 15, No. 2, 15-26 (Feb 60). (SB-60-3498)

8253J "A Method of Evaluating the Intensity of Radio Signals Reflected from Moon's Surface," M. P. Dolukhanov, 15, No. 5, 5-8 (May 60). (SB-61-421; ET-61-2187; TT-62/1-62-11174)

8254J "Reflection of Longitudinally Polarized Waves from a Rectangular Ridged Structure [A 'Comb']," L. N. Deryugin, 15, No. 5, 9-16 (May 60). (SB-60-5620)

8255J "The Scattering of Electromagnetic Waves by a Randomly Corrugated Surface of Finite Conductivity," A. A. Kovalev and S. I. Pozdnyak, 16, No. 12, 31-36 (Dec 61). (SA-62-13694)

RADIOTEKHNIKA [MOSCOW] (USSR) (CONT.)

8256J "Properties of the Current Density Distribution at the Surface of a Thin Strip and of an Elliptic Cylinder in the Diffraction of Cylindrical Electromagnetic Waves," V. P. Mandrazhi, 17, No. 5, 34-46 (May 62). (SB-62-11298; I-A63-10166)

8257J "Rapid Processes in the Ionosphere," N. D. Bulatov and E. I. Khristova, 17, No. 12, 28-32 (Dec 62). (I-A63-19204)

8258J "A Case of Reflection of Electromagnetic Waves from a Periodic Structure," G. Sh. Kevanishili and D. K. Kvavadze, 19, 27-31 (Nov 64). (I-A65-13874)

RADIOTEKHNIKA I ELEKTRONIKA (USSR) [Cover-to-Cover Translation]

8259J "Theory of Scattering of Radio Waves at Moving Inhomogeneities," G. S. Gorelik, 1, No. 6, 695-703 (Jun 56). (ET-57-1884)

8260J "Influence of Large Irregularities of the F_2 Layer on the Reflection Coefficient of Radio Waves," L. A. Drachev and Iu. V. Berezin, 2, No. 10, 1234-39 (1957). (SB-59-557)

8261J "On the Statistical Character of the Scattering of Centimeter Waves by an Agitated Sea-Surface," S. Ya. Braude, N. N. Komarov, and I. E. Ostrovskii, 3, No. 2, 172-79 (1958). (SA-59-3670; TT-60/1-59-20690)

8262J "On the Theory of Scattering of Electromagnetic Waves by a Statistically Uneven Surface," F. G. Bass and V. G. Bocharov, 3, No. 2, 180-85 (1958). (SB-59-2208)

8263J "The Scattering of Electromagnetic Waves from Sinusoidal and Trochoidal Surfaces of Finite Conductivity," V. I. Aksenov, 3, No. 4, 459-66 (1958). (SB-59-2209; TT-60/1-59-20688)

8264J "Asymptotic Solution of the Problem of Diffraction of Plane Electromagnetic Wave on a Conducting Cylinder," A. S. Goryainov, 3, No. 5, 603-14 (1958). (SB-59-4705)

8265J "The Simplest Case of the Diffraction of a Plane Wave by a Gyrotropic Cylinder,' V. V. Nikol'skii, 3, No. 6, 756-59 (1958). (SB-59-2858)

8266J "The Diffraction of an Electromagnetic Wave by a Semi-Infinite Mesh," Ia. N. Fel'd, 3, No. 7, 882-89 (1958). (SB-59-3553)

8267J "Method of Finite Conductivity in the Theory of Diffraction of Electromagnetic Waves," R. G. Mirimanov, 3, No. 7, 971-72 (1958). (TT-60/1-59-20687)

8268J "The Asymptotic Solution of the Problem of Diffraction of Plane Electromagnetic Waves by an Ideally Conducting Sphere," A. A. Fedorov, 3, No. 12, 1451-62 (1958). (SB-60-2228; TT-59/2-59-14901)

8269J "The Diffraction of Plane Waves by a Wire Grid Situated Inside a Dielectric Slab," V. G. Yampol'skii, 3, No. 12, 1516-18 (1958). (SB-60-2230)

8270J "The Location of Irregularities in the Ionosphere," A. A. Gorozhankina, 4, No. 1, 131 (Jan 59). (SB-61-414)

8271J "Diffraction in a Non-Uniform Field," V. P. Peresada, 4, No. 3, 384-87 (Mar 59). (SA-61-5591)

8272J "Application of the Turbulence Theory to the Scattering of Radio Waves on Randomly Moving Inhomogeneities," M. I. Rodak and A. V. Frantsesson, 4, No. 3, 398-403 (Mar 59). (SB-61-2689; ET-60-3634)

RADIOTEKHNIKA I ELEKTRONIKA (USSR) (CONT.)

8273J "Calculation of Phase Velocities of Radio Waves in an Artificial Metal-Dielectric," Ia. N. Fel'd and L. S. Benenson, 4, No. 3, 417-27 (Mar 59). (ET-60-3379)

8274J "Radio Echoes from the Moon in the X and S Bands," M. M. Kobrin, 4, No. 5, 892-94 (May 59). (SB-61-6446)

8275J "The Diffraction of Electromagnetic Waves by Dielectric or Semiconducting Sheets," A. A. Pistol'kors, V. A. Kaplun, and L. V. Knyazeva, 4, No. 6, 911-19 (Jun 59). (SA-61-5592)

8276J "The Phase Velocity of Waves in an Anisotropic Artificial Metal-Dielectric for an Arbitrary Direction of Propagation," L. S. Benenson, 4, No. 11, 1806-15 (Nov 59). (SB-61-6188)

8277J "Short-Wave Asymptotic Function Analysis of a Diffraction Field in the Shadow of an Ideal Parabolic Cylinder," V. I. Ivanov, 5, No. 3, 393-402 (Mar 60). (SB-61-4783; I-61-7242)

8278J "Diffraction of Short Plane Electromagnetic Waves by a Smooth Convex Cylinder at Oblique Incidence," V. I. Ivanov, 5, No. 3, 524-28 (Mar 60). (SB-61-6189; I-61-7238)

8279J "Dispersional Properties of 2- and 3-Dimensional Periodic Systems (Artificial Dielectrics)," R. A. Silin, 5, No. 4, 688-91 (Apr 60). (SA-62-7757)

8280J "Experimental Investigation of the Scattering of Electromagnetic Waves from Periodically Varying Surfaces," V. I. Aksenov, 5, No. 5, 782-95 (May 60). (SB-61-4785; I-61-7237)

8281J "Diffraction of a Plane Electromagnetic Wave by a Metallic Elliptical Semi-Cylinder on a Metallic Plane," M. S. Antonovskii, 5, 861-63 (May 60). (I-61-7243)

8282J "The Scattering of Non-Monochromatic Radiation by Wandering Inhomogeneities," M. A. Rodak, 5, No. 9, 1370-79 (Sep 60). (SB-62-1201)

8283J "Distant Scattered Reflection from Earth on Short Waves," N. I. Kabanov, 5, No. 10, 1576-92 (Oct 60). (SB-61-6436; I-61-9269)

8284J "The Reflection of Circularly Polarized Electromagnetic Waves from Metallic Bodies," E. N. Maizel's and P. Ya. Ufimtsev, 5, No. 12, 1925-28 (Dec 60). (SB-61-4571)

8285J "The Scattering of Plane and Cylindrical Waves by an Elliptical Cylinder and the Concept of Diffraction Rays," L. A. Vainshtein and A. A. Fedorov, 6, No. 1, 31-46 (Jan 61). (SB-62-2635; I-62-470)

8286J "The Diffraction of a Plane Electromagnetic Wave Propagating Along the Axis of a Cone," A. S. Goryainov, 6, No. 1, 47-57 (Jan 61). (SB-62-2636; I-62-460)

8287J "The Incidence of a Plane Electromagnetic Wave on a Plane Grid (H Vector Parallel to the Wires)," A. N. Sivov, 6, No. 1, 58-66 (Jan 61). (SB-62-2637)

8288J "The Perturbation Method and Its Connection with the Strict Diffraction Method in the Solution of Problems of Non-Coherent Scattering," A. V. Shabel'nikov, 6, No. 2, 204-13 (Feb 61). (SB-61-7041; I-61-10276)

8289J "The Application of Kirchhoff's Approximation to the Scattering of Electromagnetic Waves from Periodically Non-Level Surfaces of Finite Conductivity," V. I. Aksenov, 6, No. 3, 347-54 (Mar 61). (SB-62-2638; I-61-10273)

RADIOTEKHNIKA I ELEKTRONIKA (USSR) (CONT.)

8290J "Transverse Diffusion at Diffraction in an Impedance Cylinder of Great Radius. I. Parabolic Equation in Beam Co-ordinates," G. D. Malyuzhinets and L. A. Vainshtein, 6, No. 8, 1247-58 (Aug 61). (SB-62-2641)

8291J "Transverse Diffusion in Diffraction by an Impedance Cylinder of Large Radius. II. Asymptotic Laws of Diffraction in Polar Coordinates," L. A. Vainshtein and G. D. Malyuzhinets, 6, No. 9, 1489-95 (1961).

8292J "Reflection of Circularly Polarized Radio Waves by Metallic Bodies," P. Ia. Ufimtsev, 6, 2094-95 (Dec 61). (I-62-3623; I-62-6855)

8293J "Diffraction of Electromagnetic Waves by Intersecting Cylinders," M. V. Butrov, 7, No. 1, 167-68 (Jan 62). (SB-62-12435; I-62-5836; I-62-7822)

8294J "Scattering of Electromagnetic Waves by Meteor Trails," M. D. Khaskind, 7, 189-205 (Feb 62). (I-62-5829)

8295J "Scattering of Fluctuating Waves by Objects of Large Dimensions," E. A. Shtager, 7, No. 2, 202-05 (Feb 62). (SA-63-18703; I-62-5832)

8296J "The Scattering of Electromagnetic Waves by Meteor Trails," M. D. Khaskind, 7, No. 2, 206-22 (Feb 62). (SB-63-1033; SB-63-12280)

8297J "Reflection Coefficient for a Plane Electromagnetic Wave Reflected from a Plane Wire Grid," M. I. Kontorovich, V. Yu. Petrun'kin, N. A. Esepkina, and M. I. Astrakhan, 7, No. 2, 239-49 (Feb 62). (SB-63-590; SB-63-11718)

8298J "Diffraction of Plane Electromagnetic Waves by a Thin Cylindrical Conductor," P. Ya. Ufimtsev, 7, No. 2, 260-69 (Feb 62). (SB-63-592; SB-63-11719)

8299J "The Attenuation Function of Radio Waves Scattered from Meteor Trails," M. D. Khaskind, 7, No. 2, 343-45 (Feb 62). (SB-63-2248)

8300J "Reflection of Radio Waves by Inclined Meteorite Trail," M. D. Khaskind, 7, 558-67 (Apr 62). (I-62-10816)

8301J "Reflection of Radio Waves from Inclined Meteor Trails," M. D. Khaskind, 7, No. 4, 590-600 (Apr 62). (SB-63-1034; SB-63-13879; I-62-10816)

8302J "Diffraction of a Cylindrical Wave by a Half-Plane," B. E. Kinber, 7, No. 7, 1247-48 (Jul 62). (SB-63-13206)

8303J "Results Obtained with the Venus Radar Probe in 1961," V. A. Kotel'nikov, V. M. Dubrovin, V. A. Morozov, et al., 7, 1860-72 (Nov 62). (SB-63-3379; I-A63-11733; I-A63-20082)

8304J "The Theory of Ribbon Arrays of Finite Period," V. V. Malin, 8, No. 2, 211-20 (Feb 63). (SB-63-5963)

8305J "Transverse Diffusion When Short Waves Are Diffracted at a Convex Cylinder with Smoothly Varying Curvature. I and II," V. A. Fok and L. A. Vainshtein, 8, No. 3, 363-88 (Mar 63). (SB-63-7217; SB-63-7218; I-A63-16345; I-A63-16346; I-A64-10428)

8306J "Diffraction of a Plane Electromagnetic Wave by an Ideally Conducting Sphere of Large Radius," Iu. A. Erukhimovich and Iu. V. Pimenov, 8, 394-99 (Mar 63). (SB-63-7219; I-A63-16347; I-A64-10431)

8307J "Diffraction of a Plane Electromagnetic Wave by a Circular Plasma Cylinder," Iu. N. Dnestrovskii and D. P. Kostomarov, 8, 408-15 (Mar 63). (SB-63-7220; (I-A63-16349; I-A64-10433)

RADIOTEKHNIKA I ELEKTRONIKA (USSR) (CONT.)

8308J "Resonance Scattering of Radio Waves by Satellite Trails," Iu. S. Saiasov and L. A. Zhizhimov, 8, 499-502 (Mar 63). (I-A64-10446)

8309J "Diffraction of a Plane Electromagnetic Wave by a System of Metallic Strips," V. G. Yampol'skii, 8, 564-76 (Apr 63). (SB-63-11720; I-A63-19876; I-A64-15214)

8310J "Diffraction of Electromagnetic Waves at a Plane Metal Grating with Shield (Case of Arbitrary Incidence)," A. I. Adonina and V. P. Shestopalov, 8, 950-58 (Jun 63). (SB-63-11721; I-A63-19168; I-A64-17560)

8311J "Scattering of Electromagnetic δ-Pulses by Ideally Conducting Bodies of Finite Dimensions," Iu. N. Barabanenkov, A. A. Tolkachev, N. A. Aytkhozhin, and O. K. Lesota, 8, 1069-71 (Jun 63). (I-A64-17569)

8312J "Electromagnetic Wave Diffraction on Multi-Layer Plane, Metal Grids (The Case of Normal Incidence and E-Polarization)," L. N. Geivandov, O. A. Tret'yakov, and V. P. Shestopalov, 8, 1361-73 (Aug 63). (I-A63-25292; I-A64-17674)

8313J "Average Boundary Conditions on a Grid Surface with Square Cells," M. I. Kontorovich, 8, No. 9, 1506-15 (Sep 63). (SB-64-6538)

8314J "Electromagnetic Wave Diffraction on a Three-Dimensional Periodic Lattice Consisting of Bars with a Rectangular Cross Section," S. A. Masalov and I. E. Tarapov, 9, 53-60 (Jan 64). (SB-65-7664; I-A64-15780; I-A64-24414)

8315J "On Lemb's Error in the Problem of Diffraction on a Thin Round Rod Lattice," B. Z. Katsenellenbaum and A. N. Sivov, 9, No. 2, 360-61 (Feb 64). (SB-64-15287)

8316J "Excitation of an Ideally Conducting Body of Revolution in the Presence of a Sphere Lying Along the Same Axis," Ye. N. Vasil'yev, A. R. Seregina, and V. G. Kamenev, 9, 471-78 [pages of translated version] (Apr 64).

8317J "Electromagnetic Wave Diffraction on Double Semi-Infinite Asymmetric Arrays," Ia. N. Fel'd, 9, 950-59 (Jun 64). (I-A64-21074; I-A65-14901)

8318J "The Effect of Polarization on Radio Signals Scattered by Meteor Trails," M. F. Lagutin and B. L. Kashcheev, 9, 1494-95 (Aug 64). (I-A64-28031; I-A65-20336)

8319J "Problem of the Scattering of an Electromagnetic Wave on a Rough Surface," V. A. Kashin and V. V. Merkulov, 9, 1578-80 (Sep 64). (SB-65-7653; I-A64-27547; I-A65-20503)

8320J "Calculation of Multiple Diffraction by the Scattering Matrix Method," B. E. Kinber, 9, 1594-1604 (Sep 64). (SB-65-7654; I-A64-27549; I-A65-20505)

8321J "Problem of the Diffraction of a Uniform Plane Electromagnetic Wave by an Impedance Wedge," M. S. Bobrovnikov and V. N. Kislitsyna, 9, 1696-1700 (Sep 64). (SB-65-7655; I-A64-27561; I-A65-20518)

8322J "Asymptotic Diffraction Formulas for Spheres with Arbitrary Distribution of the Source and Observation Point," A. A. Fedorov, 9, 1702-06 (Sep 64). (SB-65-7656; I-A64-27563; I-A65-20520)

8323J "Microwave Screening Properties of Wire Grids," V. A. Kaplun, N. I. Babkin, and B. G. Goriachev, 9, 1723-24 (Sep 64). (SB-65-7657; I-A64-27568)

8324J "Reflecting Power of Metal Films at Microwaves and Radio Frequencies," A. E. Kaplan, 9, No. 10, 1781-87 (Oct 64). (SB-65-7658; I-A65-24057)

RADIOTEKHNIKA I ELEKTRONIKA (USSR) (CONT.)

8325J "Diffraction of Plane Waves on a Slot and on a Tape," M. D. Khaskind and L. A. Vainshtein, 9, No. 10, 1800-11 (Oct 64). (SB-65-7659; I-A65-24059)

8326J "Reflection of Electromagnetic Waves from a Corrugated Surface with a Small Period," A. N. Sivov, 9, No. 10, 1821-27 (Oct 64). (SB-65-7662; I-A64-28257; I-A65-24060)

8327J "Diffraction of a Plane Electromagnetic Wave Near a Cylindrical Conductor in a Plane Dielectric Layer," V. A. Kaplun and A. A. Pistol'kors, 9, 1948-57 (Nov 64). (SB-65-10271; I-A65-10436; I-A65-23898)

8328J "Diffraction of an H-Polarized Plane Electromagnetic Wave from a Plane Array with a Dielectric," S. A. Masalov, Iu. T. Repa, and E. D. Sitnikov, 9, 2071-77 (Dec 64). (SB-65-9667; I-A65-14133; I-A65-24008)

RCA REVIEW

8329J "Pulsed Radar Measurement of Back-Scattering from Spheres," S. B. Adler, 23, 80-95 (Mar 62). (SB-62-10153; I-62-5809; ET-62-2330)

8330J "Electromagnetic Properties of Finite Plasmas," M. P. Bachynski and K. A. Graf, 25, 3-53 (Mar 64). (I-A64-17089)

REPORT OF IONOSPHERE AND SPACE RESEARCH IN JAPAN

8331J "New Type of Scattering Echo Observed by the Ship-Borne Ionospheric Sounder Over the Sea," H. Okamoto, M. Ose, and K. Aida, 11, 50-54 (Jun 57). (ET-58-1237)

8332J "On the Possibility of the Upper Atmospheric Sounding by Optical Radar," Y. Kato, Y. Mori, and H. Inaba, 18, 103-08 (Jun 64). (I-A65-10214)

REPORTS OF THE RESEARCH INSTITUTE OF ELECTRICAL COMMUNICATION, TOHOKU UNIVERSITY. SENDAI (JAPAN)

8333J "Diffraction of Electric Waves by Circular Plate and Circular Hole," Y. Nomura and S. Katsura, 10, No. 1, 1-43 (1958). (SA-63-493)

8334J "Effects of the Dielectric Coatings with Non-Uniform Thickness on the Radar Cross Section of the Perfectly Conducting Sphere," A. Komata and Y. Mushiake, 11, No. 3-4, 191-201 (1960). (SB-61-6466; ET-61-900)

RESEARCH TRENDS (CORNELL AERONAUTICS LABORATORY)

8335J "Radar Cross Sections and Defense Against Missiles," S. Chapman and G. Graham, 8, 1-4 (Winter 1961). (I-61-4239)

REVIEWS OF GEOPHYSICS

8336J "Radar Studies of the Planets," R. M. Goldstein, 2, 579-92 (Nov 64). (SA-65-13745; I-A65-14454)

REVIEWS OF MODERN PHYSICS

8337J "An Approximation Method for Diffraction Problems," K. M. Case, 36, 669-79 (Apr 64). (SA-64-21022)

REVUE D'OPTIQUE (FRANCE)

8338J "Scattering of Electromagnetic Waves by Small Particles," O. Gherman and F. Constantinescu, 42, 3-7 (Jan 63). (SA-63-14772)

8339J "Tensor Formulation of the Diffraction Problem by the Method of Retarded Potentials," R. Le Naour, 43, 373-75 (Jul 64). (SA-65-4955)

REVUE TECHNIQUE DE LA COMPAGNIE FRANCAISE THOMSON-HOUSTON (FRANCE)

8340J "Surveillance Radar: Theoretical Study of Frequency Diversity," J. Leger, 39, 31-45 (Dec 63). (SB-65-1376)

SCIENCE

8341J "Radar Echoes from Venus," R. Price, P. E. Green, T. G. Goblick, et al., 129, 751-53 (Mar 59). (MG-60-11H-120; MG-61-12J-57)

8342J "Project Teepee Monitors Missile Shots and Upper Air Explosion," 130, 491 (Aug 59). (MG-62-13.4-109)

8343J "Radar Echoes from the Sun," V. R. Eshleman, R. C. Barthle, and P. B. Gallagher, 131, 329-32 (Feb 60). (SA-60-4871; MG-60-11L-120; ET-60-2716)

8344J "Exploration of Venus by Radar," W. K. Victor and R. Stevens, 134, 46-48 (Jul 61). (SA-61-15560; MG-61-12J-75; I-61-6570)

8345J "Radar Observations of Venus," I. Maron, G. Luchak, and W. Blitzstein, 134, 1419-21 (Nov 61). (I-61-10537; ET-62-1248)

8346J "Radar Observations of Mars," R. M. Goldstein and W. F. Gillmore, 141, 1171-72 (Sep 63). (I-A63-25015)

8347J "Radar Observations of Mercury," R. L. Carpenter and R. M. Goldstein, 142, 381 (Oct 63). (I-A63-25078)

8348J "Radar Observations of Jupiter," R. M. Goldstein, 144, 842-43 (May 64). (I-A64-19007)

8349J "Radar Observations of the Corona and Mariner II Measurements of the Flux in the Solar Wind," J. C. Brandt, 146, 1671-72 (Dec 64). (SA-65-13780; I-A65-13169)

SCIENTIA SINICA (CHINA)

8350J "Radar Equation by Taking into Consideration the Coherent Scattering of Radar Waves from Cloud and Raindrops," Lee Chi-Chen, 12, 695-708 (May 63). (I-A63-22099)

8351J "Low-Frequency Scattering by Polygonal Cylinders," W. G. Lin and W. Y. Pen, 13, 1381-96 (Sep 64). (SA-65-2261; I-A64-28412)

SCIENTIFIC AMERICAN

8352J "Radar Astronomy," V. R. Eshleman and A. M. Peterson, 203, 50-59 (Aug 60). (MG-60-11L-119)

SHELL AVIATION NEWS (GB)

8353J "Angels on Radar," E. Eastwood, 2-6 (Aug 60). (I-61-1723)

SLABOPROUDY OBZOR (CZECHOSLOVAKIA)

8354J "Diffraction of an Arbitrarily Polarized Electromagnetic Wave by a Generally Oriented Subcritical Meteoritic Trail," B. Chytil, 24, 214-18 (1963). (SB-63-10089)

SMITHSONIAN CONTRIBUTIONS TO ASTROPHYSICS

8355J "Limitations of Radar Techniques for the Study of Meteors," J. S. Greenhow, 7, 5-17 (1963). (I-A63-23579)

SPACE SCIENCE REVIEWS (NETHERLANDS)

8356J "Radio Aurora," B. Hultqvist and A. Egeland, 3, 27-78 (Jul 64). (I-A64-25262)

STATE INSTITUTE FOR TECHNICAL RESEARCH. PUBLICATIONS (FINLAND)

8357J "Investigations of Radio Reflections from Satellite-Produced Ion Trails Using 100 Mc C. W. Radar," M. Tiuri, No. 59, 47 pp (1960). (SB-61-4820)

TECHNIKA CHRONIKA (GREECE)

8358J "Statistical Study of Microwave Propagation Through the Turbulent Troposphere (Evaluation of Scattering Cross Section and Amplitude and Phase Fluctuation)," J. Nicolis, 41, No. 2A, 1-26 (Apr 64). (SB-64-15962)

TELLUS (SWEDEN)

8359J "Observations of the Micro-Structure of a Radar Bright Band and Associated Shower," E. N. Brown, 16, No. 4, 517-22 (Nov 64). (SB-65-6616)

TEXAS JOURNAL OF SCIENCE

8360J "Radar Observations of Blackbird Flights," M. G. H. Ligda, 10, 255-65 (Sep 58). (SB-59-2526; MG-60-11H-95)

TIJDSCHRIFT VAN HET NEDERLANDS ELEKTRONICA (NETHERLANDS)

8361J "Theoretical Aspects of the Atmospheric Scattering of Radio-Waves," H. Bremmer, 22, No. 2, 87-106 (Mar 57). (SB-57-4745)

8362J "An Adjustable Polarizer for the Suppression of Rain Echoes in Pulse Radar," M. H. Bodmer, 24, Nos. 2/3, 63-70 (1959). (SB-59-6783; ET-60-3884)

TNB GENERAL PRECISION AEROSPACE

8363J "Doppler Radar Errors Over Water," J. A. Losier, 7, 4th Quarter, 10-17 (1964). (I-A65-16323)

TRANSACTIONS OF THE AMERICAN GEOPHYSICAL UNION

8364J "Radar Astronomy," G. H. Pettengill, 44, 453-55 (Jun 63). (I-A63-19974)

TRANSACTIONS OF THE SOUTH AFRICAN INSTITUTE OF ELECTRICAL ENGINEERS

8365J "The Measurement of Rainfall Over Large Areas Using Radar," M. C. Hodson, 55, Pt. 7, 233-51 (Jul 64). (SB-65-10320)

TSENTRAL'NAIA AEROLOGICHESKAIA OBSERVATORIIA [MOSCOW], TRUDY (USSR)

8366J "Radio Location Studies of Precipitation Using Standard Targets," A. B. Shupiatskii, No. 22, 89-95 (1957). (MG-59-10.8-136)

8367J "Experience in Radar Troposphere Sounding," V. V. Kostarev, No. 20, 3-16 (1958). (TT-60-ATS-62L34R)

8368J "Radar Scattering by Non-Spherical Particles," A. B. Shupiatskii, No. 30, 39-52 (1959). (MG-62-13.5-127)

UKRAINS'KII FIZICHNII ZHURNAL (USSR)

8369J "The Reflection of Radar Signals from the Sun," F. G. Bass and S. Ya. Braude, 2, No. 2, 149-64 (1957). (SA-58-7653)

8370J "The Scattering of Electromagnetic Waves by Turbulent Pulsations, Taking into Account the Average Flow Curl," V. I. Mykhailov, 3, No. 3, 351-57 (1958). (SA-61-13182)

8371J "The Phase Structure of the Field and Velocity of Medium Range Radiowave Distribution Over the Sea Surface During Turbulence," V. L. Herman, 3, No. 6, 712-20 (1958). (SA-61-13183)

8372J "Structure of Thunderstorm Showers According to the Data of the Intensity Distribution of a Radio Echo with Height," M. L. Markovych and V. M. Muchnyk, 5, No. 2, 259-69 (1960). (SA-61-20833)

8373J "Scattering of Radio Waves by a Sum of Scatterers," L. A. Pospyelov, 6, No. 2, 245-47 (1961). (SA-62-5475)

8374J "Investigation of the Absorption and Scattering of Millimetre Waves in Precipitations," O. Ya. Usikov, V. L. Herman, and I. Kh. Vakser, 6, No. 5, 618-41 (1961). (SA-62-9713)

8375J "The Scattering of Electromagnetic Waves on Uneven Surfaces," V. I. Mikhailov, 7, No. 12, 1274-79 (1962). (SA-63-21975)

UKRAINSKII MATEMATICHESKII ZHURNAL (USSR)

8376J "Solution of the Inverse Diffraction Problem," D. Ya. Petrina, 12, No. 4, 476-79 (1960). [Trans: OTS 62-11505; AD 255 678]. (TT-62/1-62-11505)

UMSCHAU (GERMANY)

8377J "Measurement of Sea Disturbance: A New Application of Radar," H. U. Roll, 54, 618-19 (Oct 54). (MG-58-9.3-78)

8378J "Recent Information on Auroras from Observations During the IGY, Pt. 2, Auroral Observations by Means of Reflection of Ultrashort Waves," G. Lange-Hesse, 61, 373-76 (Jun 61). (MG-62-13.10-201)

USPEKHI FIZICHESKIKH NAUK (USSR) [Cover-to-Cover Translation]

8379J "Fresnel Diffraction from Convex Bodies," V. A. Fok, 43, 587-99 (1951). (TT-59/2-59-20285)

8380J "The Reflection of Limited Wave Trains and Impulses," L. M. Brekhovskikh, 50, 539-76 (1953). (TT-59/1-59-14096)

8381J "Some Problems of Ionosphere Physics. I. Fluctuation(s) of Electron Densities and Scattering of Radio Waves.," Ya. L. Al'pert, 61, 423-50 (1957). (TT-59/1-59-11982)

USPEKHI FIZICHESKIKH NAUK (USSR) (CONT.)

8382J "Radar Reflections from Aurorae," B. A. Bagaryatskii, 73, 197-241 (Feb 61). (SA-62-9021; I-61-7466; I-61-9430; TT-61/2-61-27265)

8383J "Effects Caused by an Artificial Satellite in Its Rapid Motion Through the Ionosphere or the Interplanetary Medium," Ia. L. Al'pert, A. V. Gurevich, and L. P. Pitaevskii, 79, 23-80 (Jan 63). (I-A63-13545)

WELTRAUMFAHRT (GERMANY)

8384J "The Moon as a Reflector for Radio Waves," P. Lengrusser, 10, No. 3, 83-86 (Sep 59). (MG-60-11L-126)

WIRELESS WORLD (GB)

8385J "More on the 'Plymouth Effect,'" J. P. Grant, 64, 587-90 (Dec 58). (ET-59-577)

WISSENSCHAFTLICHE ZEITSCHRIFT DER HOCHSCHULE FÜR ELEKTROTECHNIK [ILMENAU] (GERMANY)

8386J "The Reflection of Electromagnetic Waves from Rough Surfaces," P. Beckmann, 3, No. 3-4, 247-50 (1957). (SB-58-4928)

ZEITSCHRIFT FÜR ANGEWANDTE MATHEMATIK UND MECHANIK (GERMANY)

8387J "Diffraction of Plane Waves from a Screen," R. Leis, 43, T16-T20 (Apr 63). (I-A64-15392)

8388J "A System of Singular Integral Equations Obtained from the Theory of Bending of Electromagnetic Waves at Dielectric Wedges," E. Meister and N. Latz, 44, T47-T49 (1964). (I-A65-16849)

ZEITSCHRIFT FÜR ANGEWANDTE MATHEMATIK UND PHYSIK (SWITZERLAND)

8389J "On the Scattering of [Sound] Waves by a Disk," A. E. Heins and R. C. MacCamy, 11, 249-64 (Jul 60). (SA-60-19303)

8390J "On the Radar Backscatter from Ice-Water Mixtures," J. Joss and R. List, 14, 376-80 (Jul 63). (SA-64-8951; I-A63-23576)

8391J "On the Back-Scatter Cross-Sections of Ice Spheres," K. M. Glover and D. Atlas, 14, 563-73 (Sep 63). (SA-64-8950; I-A63-25838)

8392J "Determination of the Backscattering Cross Sections of Ice-Water Mixtures at a 5.05 cm Wavelength," J. Joss, 15, 509-39 (Sep 64). (SA-65-7486; I-A65-10157)

ZEITSCHRIFT FÜR ANGEWANDTE PHYSIK (GERMANY)

8393J "Wide-Band Resonance Absorber for Centimetre Electromagnetic Waves," H. J. Schmitt, 8, No. 8, 372-82 (Aug 56). (ET-57-1064)

8394J "Multi-Circuit Resonance Absorbers for Centimetric Electromagnetic Waves," H. J. Schmitt and W. Futtermenger, 10, No. 1, 1-7 (Jan 58). (SB-58-5356)

8395J "The Absorption of Electromagnetic Centimeter Waves in Artificially Anisotropic Media," R. Pottel, 10, No. 1, 8-16 (Jan 58). [Trans.: SLA 61-16098]. (SA-58-7208; TT-61-61-16098)

8396J "Absorption of Electromagnetic Waves with the Help of Loaded Resonant Slots," F. Wiekhorst, 10, No. 4, 173-78 (Apr 58). (SB-58-6228)

8397J "Polarization Dependence and Angular Distribution of the Reflection Coefficient of Absorbers for Electromagnetic Centimetre Waves," K. Walther, 10, No. 6, 285-95 (Jun 58). (SA-59-7214)

ZEITSCHRIFT FÜR ANGEWANDTE PHYSIK (GERMANY) (CONT.)

8398J "Experimental Determination of the Radar Scatter Cross-Section of Cylindrical Metal Objects," E. Meyer, H. Kuttruff, and H. Severin, 11, No. 1, 1-6 (Jan 59). (SA-59-9880; ET-60-1628)

8399J "Multilayer Absorbers for Electromagnetic Waves," H. J. Schmitt, 11, No. 9, 335-39 (Sep 59). (ET-60-3454)

8400J "Wide-Band Absorbers for Electromagnetic Waves," J. Deutsch and P. Thust, 11, No. 12, 453-55 (Dec 59). (ET-61-121)

8401J "The Diffraction of Electromagnetic Waves [by a Conducting Circular Cylinder]," R. King, 12, No. 2, 88-95 (Feb 60). (SA-60-5402; ET-61-504)

8402J "Inhomogeneous Waves in the Diffraction Field Near Loss-Free Dielectric Circular Cylinders," V. Muller, 12, No. 5, 206-12 (May 60). (SA-60-11050; ET-61-1473)

8403J "A Dipole Absorber for Centimetre Waves with Reduced Reflection for Oblique Incidence," G. Kurtze and E. G. Neumann, 12, No. 9, 385-93 (Sep 60). (SA-60-19933; ET-61-2545)

8404J "Diffraction of Electromagnetic Waves by Rectangular Apertures in Flat Screens," H. Severin and K. Korper, 13, No. 1, 41-47 (Jan 61). (SA-61-7148; ET-61-3343)

8405J "The Absorption of Electromagnetic Waves Over a Wide Frequency Range by a Thin Homogeneous Lossy Film," H. W. Helberg, 13, No. 5, 237-45 (May 61). (SA-61-19033; ET-62-458)

8406J "Experiments on the Diffraction of Microwaves at Plane Lattices," E. M. Amrhein and A. Dietzel, 13, No. 5, 245-47 (May 61). (ET-62-456)

8407J "Diffraction of Electromagnetic Waves from Metallic Cylinders Covered with an Absorbing Layer," V. Muller, 14, No. 10, 612-20 (Oct 62). (SA-63-4273)

8408J "Angular Dependence of the Reflection Factor of (Microwave) Absorbers Composed of Several Lossy Homogeneous Layers Followed by a Short-Circuit Plate," W. Jutzi, 14, No. 11, 692-95 (Nov 62). (SA-63-4270)

8409J "Slot Absorbers for Centimetre Electromagnetic Waves," S. Luhmann, 15, No. 6, 534-41 (Jun 63). (SA-63-24474)

8410J "A Multi-Layer Absorber for Centimetre Electromagnetic Waves," H. W. Helberg and C. Wunsche, 16, No. 3, 157-62 (1963). (SA-64-5803)

8411J "The Absorption of Electromagnetic Waves by a Thin Layer of Material Separated by a Small Distance from a Metallic Plane," H. W. Helberg, 16, No. 4, 214-20 (Oct 63). (SA-64-5802)

8412J "The Attenuation of a Plane Electromagnetic Wave in an Interplanar Region with One Face Covered by Absorbing Material," F. Horing, 16, No. 6, 460-66 (Dec 63). (SA-64-14885)

8413J "A New Principle for the Reflection of Electromagnetic Waves," E. G. Neumann, 18, No. 2, 71-76 (Nov 64). (SA-65-14101)

ZEITSCHRIFT FÜR GEOPHYSIK (GERMANY)

8414J "Seasonal Influences on V.H.F. Aurora Backscatter in Middle Europe," G. Lange-Hesse, 29, No. 1, 35-44 (1963). (SA-63-18562)

ZEITSCHRIFT FÜR METEOROLOGIE (GERMANY)

8415J "On the Partial Reflection of Electro-magnetic Waves in the Troposphere," H. Israel and K. Sommermeyer, 3, 32-39 (Jan-Feb 49). (MG-57-8I-63)

ZEITSCHRIFT FÜR NATURFORSCHUNG (GERMANY)

8416J "The Diffraction of Electromagnetic Waves at an Infinitely Long Circular Cylinder," R. Burberg, 11A, 800-06 (1956). (SA-59-481)

8417J "On the Green Function for a Transparent Cylinder," P. Beckmann and W. Franz, 12A, 257-67 (1957). (SA-59-1614)

8418J "Calculation of the Scattering Cross-Sections of a Sphere and a Cylinder Using a Modified Watson Transformation," P. Beckmann and W. Franz, 12A, 533-37 (Jul 57). (SA-59-4846)

8419J "Propagation of Microwaves Through Plane Plasma Sheaths," K. Hain and M. Tutter, 17A, 59-64 (Jan 62). (I-62-9859)

8420J "An Experimental Model Used to Determine Scattering Functions of Non-Spherical Particles by Means of 3 cm Waves," R. H. Giese and H. Siedentopf, 17A, 817-19 (Sep 62). (SA-63-4275)

8421J "Microwave Reflection from Weak Shock Waves in Air," B. Koch, 19A, 395-96 (Mar 64). (I-A64-19043)

ZEITSCHRIFT FÜR PHYSIK (GERMANY)

8422J "New Approximation Method for the Diffraction by a Plane Screen," W. Braunbek, 127, 381-90 (1950). (TT-61/1-61-10419)

8423J "Diffraction by Apertures in Non-Planar Screens," W. Braunbek, 156, 66-77 (Aug 59). (SA-59-11289; ET-60-30-60)

8424J "Diffraction of Electromagnetic Waves According to Braunbek's Approximation. I and II.," W. E. Frahn, 156, 78-98, 99-116 (Aug, Sep 59). (SA-59-11290; ET-60-3061)

ZHURNAL EKSPERIMENTALNOI I TEORETICHESKOI FIZIKI (USSR) [Cover-to-Cover Translation]

8425J "The Diffraction Field of an Ideally Conducting Sphere," A. R. Volpert and A. I. Potekhin, 17, No. 9, 802-13 (1947). (TT-59/2-59-16696)

8426J "Radiowave Scattering by Local Inhomogeneities of the Ionospheric Plasma," M. E. Certzenshteyn, 23, No. 6(12), 678-81 (1952). (TT-60-MDF G-151)

8427J "Diffraction by a Perfectly Conducting Half-Plane of Electromagnetic Waves Emitted by an Arbitrarily Oriented Electric and Magnetic Dipole," Yu. V. Vandakurov, 26, No. 1, 3-18 (1954). [Trans: SLA RT-3113; MDF V-129]. (TT-60/1-MDF-V-129)

8428J "Reflection of Waves by an Isotropic Inhomogeneous Layer," A. G. Zharkovski and O. M. Todes, 31, No. 5(11), 815-18 (Nov 56). (ET-57-2566)

8429J "Electromagnetic Properties of a Relativistic Plasma. III.," V. P. Silin and E. P. Fetisov, 41, 159-70 (Jul 61). (I-62-2249)

8430J "Reflection of Electromagnetic Waves in Gyrotropic Media from a Magnetic Field Wave," G. I. Freidman, 41, No. 1(7), 226-33 (Jul 61). (SA-61-19042)

ZHURNAL TEKHNICHESKOI FIZIKI (USSR) [Cover-to-Cover Translation]

8431J "On the Theory of Propagation of Electromagnetic Waves in Media with Randomly Non-Uniform Refractive Index," V. V. Merkulov, 27, 1051-55 (1957). (SB-58-771)

8432J "On the Inclusion of the Effect of the Thickness of the Screen in Certain Diffraction Problems," A. N. Akhiezer, 27, 1294-1300 (1957). (SA-59-5963)

8433J "Approximate Computation of the Diffraction of Plane Electromagnetic Waves at Certain Metal Bodies. I. Diffraction Patterns at a Wedge and a Ribbon," P. Ia. Ufimtsev, 27, 1840-49 (1957). (SA-59-1615)

8434J "The Diffraction of Electromagnetic Waves at Infinitely Thin, Ideally Conducting Plane Screens," G. A. Grinberg and Iu. V. Pimenov, 27, 2326-39 (1957). (SA-59-1616; ET-59-1515)

8435J "A New Method for Solving Problems Related to the Diffraction of Electromagnetic Waves by a Plane [Screen] with an Unbounded Straight Slit," G. A. Grinberg, 27, 2595-2605 (1957). (SA-59-5964)

8436J "A Method of Solving the Problems of the Diffraction of Electromagnetic Waves at Ideally Conducting Plane Screens, Based on a Study of Shadow Currents Induced on the Screens. I. General Principles of the Method," G. A. Grinberg, 28, 542-54 (1958). (SA-59-1617)

8437J "A Method of Solving the Problems of the Diffraction of Electromagnetic Waves at Ideally Conducting Plane Screens, Based on a Study of Shadow Current Induced on the Screens. II. Diffraction at a Semi-Plane and at a Plane with an Infinite Rectilinear Slit," G. A. Grinberg, 28, 555-68 (1958). (SA-59-1618)

8438J "Secondary Diffraction of Electromagnetic Waves at a Strip," P. Ia. Ufimtsev, 28, 569-82 (1958). (SA-59-1619)

8439J "Secondary Diffraction of Electromagnetic Waves on a Disk," P. Ia. Ufimtsev, 28, 583-91 (1958). (SA-58-3271)

8440J "The Plane Diffraction Problem for the Parabolic Cylinder of Finite Extension," G. A. Grinberg and Iu. V. Pimenov, 28, 2302-09 (1958). (SA-59-3671; TT-59/2-59-16742)

8441J "Diffraction of a Plane Electromagnetic Wave by a Perfectly-Conducting Paraboloid of Revolution," V. A. Fok and A. A. Fedorov, 28, 2548-66 (1958). (SA-59-9879)

8442J "Approximate Computation of the Diffraction of Plane Electromagnetic Waves at Certain Metal Bodies. II. Diffraction on a Disk and a Finite Cylinder," P. Ia. Ufimtsev, 28, 2604-16 (1958). (SA-59-9876)

8443J "Reflection of an Electromagnetic Wave from a Plasma Moving Through a Dielectric in a Constant Magnetic Field," Ya. B. Fainberg and V. S. Tkalich, 29, 491-96 (Apr 59). (ET-60-3457)

8444J "The Plane Problem of Diffraction of Electromagnetic Waves by an Ideally Conducting Strip of Finite Width," Iu. V. Pimenov, 29, 597-603 (May 59). (SA-60-11052; ET-60-3794)

8445J "Artificial Anisotropic Dielectrics Formed from Two-Dimensional Lattices of Infinite Bars and Rods," N. A. Khizhnyak, 29, 604-14 (May 59). (SA-60-11054)

8446J "A New Method for Solving the Problem of the Diffraction of Electromagnetic Waves by a Thin [Ideally] Conducting Disk," N. N. Lebedev and I. P. Skal'skaya, 29, 700-10 (Jun 59). (SA-60-7226; ET-60-4192)

ZHURNAL TEKHNICHESKOI FIZIKI (USSR) (CONT.)

8447J "The Planar Problem of the Diffraction of Electromagnetic Waves by Two Ideally Conducting (Infinitely Thin) Strips of Finite Width, Located One Below the Other," Iu. V. Pimenov, 29, 711-15 (Jun 59). (SA-60-7225; ET-60-4193)

8448J "Distribution of Current Densities on the Edges of an Ideally Conducting Rectangular Wedge Placed in the Field of a Plane Electromagnetic Wave," N. N. Lebedev and I. P. Skal'skaya, 29, 928-30 (Jul 59). (SA-60-9207)

8449J "Symmetric Electric Oscillation of an Ideally Conducting Hollow Cylinder of Finite Length," P. L. Kapitsa, V. A. Fok, and L. A. Vainshtein, 29, 1188-1205 (Oct 59). (SA-60-9206)

8450J "Diffraction of [Plane] Electromagnetic Waves by a Circular Aperture in an Ideally Conducting Plane [For Normal Incidence]," G. A. Grinberg and Iu. V. Pimenov, 29, 1206-11 (Oct 59). (SA-60-9208)

8451J "Diffraction of Electromagnetic Waves at a Paraboloidal Screen of Finite Dimensions (Axially-Symmetric Fields)," Yu. N. Kuz'min, 29, 1304-11 (Nov 59). (ET-61-505)

8452J "Diffraction of a Plane Electromagnetic Wave by a Perfectly Conducting Disk," K. A. Lur'e, 29, 1421-33 (Dec 59). (SA-60-11051)

8453J "The Scattering of Electromagnetic Waves on Free Electrons in a Strong Magnetic Field," L. E. Gurevich and S. T. Pavlov, 30, 41-43 (Jan 60). (SA-60-11020)

8454J "Measuring the Thickness of Glaciers by Electromagnetic Methods," V. N. Rudakov and V. V. Bogorodskii, 30, 82-89 (Jan 60). (SA-60-12130)

8455J "Arbitrary Incidence of a Plane Electromagnetic Wave on a Conducting Disk," V. N. Kuritsyn, 30, 790-98 (Jul 60). (SA-60-15145; SA-61-4718)

8456J "The Problem of Diffraction of Electromagnetic Waves by a Perfectly Conducting Plane Ring," G. A. Grinberg and E. N. Kolesnikova, 31, 13-17 (Jan 61). (SA-61-5593; ET-61-3723)

8457J "A Contribution to the Kinetic Theory of the Reflection of Electromagnetic Waves from a Moving Plasma," V. I. Kurilko, 31, 70-77 (Jan 61). (SA-61-5455; ET-61-3726)

8458J "The Scattering of Electromagnetic Waves by an Ideally Conducting Sphere in an Inhomogeneous Medium," Yu. S. Sayasov, 31, 261-70 (Mar 61). (SA-62-239; I-61-8243)

8459J "Diffraction of a Plane Electromagnetic Wave by an Ideally Conducting Plane Ring and the Electrostatic Problem for Such a Ring," G. A. Grinberg and V. N. Kuritsyn, 31, 1017-25 (Sep 61). (SA-62-9712)

8460J "The Solution of the 'Key' Problem of Diffraction by an Ideally Conducting Strip," V. N. Kuritsyn, 31, 1485-90 (Dec 61). (SA-62-17958)

8461J "Reflection of Electromagnetic Waves from Moving Surfaces," A. M. Kovalev and V. N. Krasil'nikov, 32, 30-33 (Jan 62). (SA-62-22333)

8462J "The Diffraction of Electromagnetic Waves from Plane Metallic Lattices," Z. S. Agranovich, V. A. Marchenko, and V. P. Shestopalov, 32, 381-94 (Apr 62). (SA-63-2124; I-62-11584)

8463J "Reflection of Electromagnetic Waves from a Moving Plasma," V. I. Kurilko and V. I. Miroshnichenko, 32, 803-10 (Jul 62). (SB-63-6273; I-A63-11013)

8464J "Electromagnetic Techniques for Assessing the Thickness of Ice Floes," V. V. Bogorodskii and V. N. Rudakov, 32, 874-82 (Jul 62). (SB-63-4783)

ZHURNAL TEKHNICHESKOI FIZIKI (USSR) (CONT.)

8465J "A New Method for Solving the Problems of Diffraction of Electromagnetic Waves by a Wedge with Finite Conductivity," N. N. Lebedev and I. P. Skal'skaya, 32, 1174-83 (Oct 62). (SA-63-14771; I-A63-12987; I-A63-15159)

8466J "Diffraction of Electromagnetic Waves by Two Non-Parallel Ideally Conducting Plates," I. P. Skal'skaya, 33, 248-51 (Feb 63). (SB-64-702; I-A63-14230; I-A63-19759)

8467J "Reflection and Refraction of Electromagnetic Waves from a Moving Interface Between Two Media," S. N. Stoliarov, 33, 565-70 (May 63). (SA-64-3143; I-A63-22812; I-A63-23623)

8468J "Diffraction of Electromagnetic Waves Obliquely Incident on a Plane Metallic Grating with a Dielectric Layer," A. I. Adonina and V. P. Shestopalov, 33, 641-51 (Jun 63). (SA-64-8936; I-A64-10133)

8469J "Reflection of Electromagnetic Waves from a Plasma," I. A. Akhiezer, 33, 935-42 (Aug 63). (SA-64-16483; I-A63-24624; I-A64-14114)

8470J "The Diffraction of Electromagnetic Waves by a Plane Double Metallic Grating," O. A. Tret'yakov and V. P. Shestopalov, 33, 1232-43 (Oct 63). (SA-64-24839)

8471J "The Diffraction of Electromagnetic Waves by a Plane Double Grating with Equal Periods and Different Slit Widths," O. A. Tret'yakov and V. P. Shestopalov, 33, 1244-51 (Oct 63). (SA-64-24840)

8472J "Reflection of Cylindrical Waves from a Wedge-Shaped Mirror with Resistive Walls," I. P. Skal'skaya, 33, 1378-83 (Nov 63). (SA-64-24834; I-A64-12096; I-A64-18337)

8473J "Solution of the Three-Dimensional Static and Wave Problems for a Screen in the Shape of an Infinite Thin Sectoral Plate," G. A. Grinberg, 33, 1387-91 (Nov 63). (SA-64-27027; I-A64-12098; I-A64-18339)

8474J "Solution of the Static and Wave Problems for Screens Shaped Like a Cone or Part of a Conical Surface," G. A. Grinberg, 33, 1392-94 (Nov 63). (SA-64-27028; I-A64-12099; I-A64-18340)

8475J "The Diffraction of Electromagnetic Waves at Grazing Incidence on a Plane Metal Grating with a Screen and Magnetodielectric," A. I. Adonina and V. V. Shcherbak, 34, 168-73 (Jan 64). (SA-64-14889)

8476J "The Experimental Investigation of the Diffraction of Electromagnetic Radiation by a Double Metal Grating," A. V. Provalov, O. A. Tret'yakov, and V. P. Shestopalov, 34, 186-88 (Jan 64). (SA-64-14890)

8477J "The Reflection and Refraction of an Electromagnetic Wave by a Layer of Field Moving in a Non-Linear Medium," A. M. Glutsyak, 34, 1345-50 (Aug 64). (SA-64-30049; I-A64-25680; I-A65-16629)

8478J "Wave Conversion on the Boundary Between Two Plasma Media," Ts. D. Loladze and N. L. Tsintsadze, 34, 1380-86 (Aug 64). (SA-64-29945; I-A65-16634)

8479J "An Experimental Investigation of the Diffraction of Electromagnetic Waves on a Plane Metallic Grid of Finite Size," V. P. Shestopalov and V. A. Slyusarskii, 34, 1649-59 (Sep 64). (SA-65-243; I-A65-17797)

8480J "Diffraction and Propagation of Electromagnetic Waves in Plane and Cylindrical Periodic Structures of Specific Geometric Shape," G. N. Gestrin, L. N. Litvinenko, K. V. Maslov, and V. P. Shestopalov, 34, 1962-70 (Nov 64). (SA-65-4956; I-A65-12696)

ZHURNAL VYCHISLITEL'NOI MATEMATIKI I MATEMATICHESKOI FIZIKI (USSR)

8481J "Diffraction of Short Plane Waves by a Parabolic Cylinder," V. I. Ivanov, 2, 241-54 (Mar-Apr 62). (SA-64-19222)

8482J "High-Frequency Asymptotic Solution of Non-Stationary Diffraction Problem (Illuminated Region)," V. V. Kravtsov, 3, 955-57 (Sep-Oct 63). (SA-64-19223)

8483J "A Method for Solution of Diffraction Problems (Case of Two Dimensions)," V. V. Kravtsov, 4, 354-58 (Mar-Apr 64). (SA-64-19220)

PAPERS FROM SYMPOSIA, CONFERENCES, CONVENTIONS, ETC.
AVAILABLE IN THE OPEN LITERATURE AS PROCEEDINGS, RECORDS, ETC.

1957--IRE NATIONAL CONVENTION [New York, New York, 18-21 March 1957.]

8484J "Sea Clutter in Radar and Sonar," R. M. Hoover and R. J. Urick, Vol. 5, Pt. 9, pp. 17-22. (SB-58-3261)

1957--6TH WEATHER RADAR CONFERENCE [Cambridge, Massachusetts, 26-28 March 1957.]

8485J "Shapes of Raindrops," D. M. A. Jones, pp. 1-7. (MG-58-9H-57)

8486J "Radar Angels at South Truro, Mass.," R. E. Richardson, J. M. Stacey, and H. M. Kohler, pp. 17-22. (MG-58-9H-83)

8487J "Comparison of Measured and Calculated Values of Depolarization for Dry Snowflakes," R. E. Newell and L. Patterson, pp. 43-49. (MG-58-9H-112)

8488J "Radar Detection of Angel Activity with Corresponding Refractometer Soundings," R. B. Leasure, K. S. Durham, J. J. Tobias, and R. A. Dudrow, pp. 261-66. (MG-58-9H-64)

8489J "Radar Echoes from Cumulus Clouds," W. G. Harper, F. H. Ludlam, and P. M. Saunders, pp. 267-72. (MG-58-9H-29)

8490J "Some Persistent 'Ring' Angels on High-Powered Radar," F. C. Elder, pp. 281-90. (MG-58-9H-113)

1957--IRE WESTERN ELECTRONIC SHOW AND CONVENTION (WESCON) [San Francisco, California, 20-23 August 1957.]

8491J "Special Applications of Metallic Reflectors for Purposes of Navigation," G. Megla, Vol. 1, Pt. 1, pp. 29-40. [Also in Hochfrequenztechnik und Elektroakustik 66, No. 4, pp. 107-15 (Jan 58)]. (SB-58-3837)

8492J "Scattering of Microwaves by Figures of Revolution," J. S. Honda, Vol. 1, Pt. 1, pp. 151-57. (SB-58-3550)

8493J "Equipment and Techniques for the Measurement of Radar Reflections from Model Targets," P. D. Kennedy, Vol. 1, Pt. 1, pp. 208-15. (SB-58-3843)

1957--ASSOCIAZIONE GEOFISICA ITALIANA CONVEGNO ANNUALE [Rome, November 1957.]

8494J "Typical Development of Radar Echoes from Thunderstorms," O. Sarrica, pp. 73-85. (MG-60-11H-129)

1958--IRE NATIONAL CONVENTION [New York, New York, 24-27 March 1958.]

8495J "The Use of Impulse Response in Electromagnetic Scattering Problems," E. M. Kennaugh and R. L. Cosgriff, Vol. 6, Pt. 1, pp. 72-77. (SB-59-568)

SYMPOSIA, CONFERENCES, CONVENTIONS, ETC. (CONT.)

1958--2ND CONFERENCE ON ATMOSPHERIC ELECTRICITY [Portsmouth, New Hampshire, May 1958.]

8496J "Radar Lightning Echoes and Atmospherics in Vertical Cross Section," D. Atlas, pp. 441-58. (MG-60-11H-2)

1958--RADIO ASTRONOMY SYMPOSIUM [Paris, France, July-August 1958. Published by Stanford University Press (1959).]

8497J "The Rapid Fading of Moon Echoes at 100 Mc/s," J. V. Evans, S. Evans, and J. H. Thomson, pp. 8-12. (SA-60-18616; MG-61-12K-102)

8498J "Radar Observations of the Moon at 10-cm Wavelength," J. S. Hey and V. A. Hughes, pp. 13-18. (SA-60-18617; MG-61-12K-110)

8499J "A Lunar Study at 10-cm Wavelength," B. S. Yaplee, N. G. Roman, K. J. Craig, and T. F. Scanlan, pp. 19-28. (SA-60-18618)

8500J "Radar Reflection Characteristics of the Moon," T. B. A. Senior and K. M. Siegel, pp. 29-46. (SA-60-18619)

1958--NATIONAL ELECTRONICS CONFERENCE [Chicago, Illinois, 13-15 October 1958.]

8501J "The Design of a Single-Layer Microwave Absorbing Material," D. L. Waidelich, Vol. 14, pp. 688-97. (SB-59-4912)

1958--AGARD AVIONICS PANEL MEETING [Copenhagen, Denmark, 20-25 October 1958. Published as Avionics Research: Satellites and Problems of Long Range Detection and Tracking (AGARDograph No. 40), Pergamon Press (1960).]

8502J "A Generalized Theory of Radar Observations," R. J. Lees, pp. 1-5. (I-61-1725)

8503J "Echoing Area Characteristics," J. S. Hey, H. Gent, and P. G. Smith, pp. 12-28. (I-61-1722)

8504J "Ground Scatter by Ionospheric Radar," W. Dieminger, pp. 29-43. (I-61-1726)

8505J "U.H.F. Radar Propagation Research," B. C. Blevis and J. H. Chapman, pp. 57-67.

8506J "Earth Satellite Observations Made with the Millstone Hill Radar," G. H. Pettengill and L. G. Kraft, Jr., pp. 125-34.

8507J "Radio Observations of the Russian Earth Satellites," J. G. Davies, pp. 135-39.

8508J "Radar Echoes Obtained from Earth Satellites 1957 Alpha and 1957 Beta," A. M. Peterson, R. L. Leadabrand, W. E. Jaye, et al., pp. 140-55.

1958--7TH WEATHER RADAR CONFERENCE [Miami Beach, Florida, 17-20 November 1958.]

8509J "The Distribution and Continuity of Echoes on CAPPI Weather Records," W. Hitschfeld and K. L. S. Gunn, Sec. A, pp. 10-16. (MG-60-11H-63)

8510J "A Comparison of Solid Hydrometeor Shape at Wavelengths of 3 CM and 5000 A," R. E. Newell, Sec. B, pp. 1-7. (MG-60-11H-113)

8511J "Vertical Profiles of Radar Echo Reflectivity in Thunderstorms," R. J. Donaldson, Jr., Sec. B, pp. 8-16. (MG-60-11H-36)

8512J "Reflectivity Measurements in the Vertical Through a Severe Squall Line," A. C. Chmela, Sec. B, pp. 17-24. (MG-60-11H-25)

8513J "Observations of the Relationship Between Raindrop-Size Distribution and the Existence of Radar Bright-Layers," R. D. Hunsucker and F. W. Decker, Sec. B, pp. 33-34. (MG-60-11H-66)

SYMPOSIA, CONFERENCES, CONVENTIONS, ETC. (CONT.)

1958--7TH WEATHER RADAR CONFERENCE (CONT.)

8514J "An Unusual Indicator of Convection," W. G. Harper, Sec. D, pp. 9-16. (MG-60-11H-57)

8515J "Radar Observations of Unusual Echoes," E. A. Mueller, Sec. D, pp. 17-21. (MG-60-11H-111)

8516J "On the Observation and Application of Angel Echoes Using the AN/CPS-9 Radar," S. G. Bigler, Sec. D, pp. 22-30. (MG-60-11H-15)

8517J "Two Examples of Non-Precipitating Echoes as Observed on AN/CPS-9 Radar," G. Luckenback, Sec. D, pp. 41-47. (MG-60-11H-99)

8518J "Measurement and Analyses of Atmospheric Echoes from Millimeter Radio Wavelengths," C. W. Tolbert, A. W. Straiton, C. O. Britt, and J. R. Garhardt, Sec. E, pp. 9-16. (MG-60-11H-148)

8519J "Intensity Measurements on Angels At 3 and 10 cm," R. E. Newell, Sec. E, pp. 50-56. (MG-60-11H-112)

8520J "Meteorological Effects on Receiver Spectra of Doppler Navigators," G. R. Welti, Sec. G, pp. 13-18. (MG-60-11H-158)

8521J "Radar Observations of Storm Structure on the Micrometeorological Scale," P. M. Austin, Sec. J, pp. 14-20. (MG-60-11H-5)

8522J "Observations of a Tornado Using the AN/CPS-9 Radar," S. G. Bigler, Sec. K, pp. 1-5. (MG-60-11H-14)

8523J "A Mesosynoptic and Radar Analysis of Two Severe New England Squall Lines," R. J. Boucher, Sec. K, pp. 14-21. (MG-60-11H-19)

8524J "A Relationship Between Echo Intensity and the Observation of Hail in New England," R. C. Copeland, Sec. K, pp. 22-30. (MG-60-11H-31)

1959--IRE NATIONAL CONVENTION [New York, New York, 23-26 March 1959.]

8525J "Terrain Return Measurements at X, K_u, and K_a Band," R. C. Taylor, Vol. 7, Pt. 1, pp. 19-26. (SB-59-6759)

8526J "Theory of Radar Return from Terrain," W. H. Peake, Vol. 7, Pt. 1, pp. 27-41. (SB-59-6781)

8527J "Sputnik II as Observed by C-Band Radar," D. K. Barton, Vol. 7, Pt. 5, pp. 67-73. (SB-60-501)

8528J "Ground Clutter Isodops for Coherent Bistatic Radar," H. A. Crowder, Vol. 7, Pt. 5, pp. 88-94. (SB-60-494)

1959--SYMPOSIUM OF THE IONOSPHERIC RESEARCH COMMITTEE, AGARD AVIONICS PANEL [Paris, France, 26-28 May 1959. Published as The Upper Atmosphere Above F2-Maximum (AGARDogra No. 42), edited by H. Poeverlein, NATO Advisory Group for Aeronautical Research and Development (1959).]

8529J "Incoherent Scattering by Free Electrons as a Technique for Studying the Ionosphere and Exosphere: Some Observations and Theoretical Considerations," K. L. Bowles, pp. 223-41. (I-61-9477)

8530J "Radar Studies of the Cislunar Medium. I--Theoretical. II--Experimental," V. R. Eshleman, R. C. Barthle, and P. B. Gallagher, pp. 291-312. (I-61-9455)

SYMPOSIA, CONFERENCES, CONVENTIONS, ETC. (CONT.)

1959--IRE WESTERN ELECTRONIC SHOW AND CONVENTION (WESCON) [San Francisco, California, 18-21 August 1959.]

8531J "Electromagnetic Effects Associated with Hypersonic Re-entry Vehicles," R. F. Whitmer, Vol. 3, Pt. 1, pp. 3-8. (SB-60-489)

1959--NATIONAL ELECTRONICS CONFERENCE [Chicago, Illinois, 12-15 October 1959.]

8532J "Radar Target Angular Scintillation in Tracking and Guidance Systems Based on Echo Signal Phase Front Distortion," D. D. Howard, Vol. 15, pp. 840-49. (SB-60-8309)

1960--8TH WEATHER RADAR CONFERENCE [San Francisco, California, April 1960.]

8533J "Thunderstorm Reflectivity Structure," R. J. Donaldson, Jr., pp. 115-25. [Also appeared in J. Meteorology, 18, 292-305 (Jun 61)]. (MG-62-13.7-535)

1960--13TH GENERAL ASSEMBLY OF URSI, COMMISSION 6 ON RADIO WAVES AND CIRCUITS [London, England, September 1960. Published as Radio Waves and Circuits, edited by S. Silver, Elsevier Publishing Co. (1963).]

8534J "The Resonance Region," J. W. Crispin, Jr., K. M. Siegel, and F. B. Sleator, pp. 11-37. (I-A64-10824)

8535J "Integral Representation for the Field Diffracted by a Strip," R. Timman and R. E. Kleinman, pp. 41-70. (I-A64-10825)

1960--13TH GENERAL ASSEMBLY OF URSI [London, England, September 1960. Published as Monograph on Ionospheric Radio, Elsevier Publishing Co. (1962).]

8536J "Radio Properties of Auroras," C. G. Little, pp. 143-53. [Discussion pp. 177-85]. (I-A63-13499)

8537J "High-Latitude Radio Aurora," L. Owren, pp. 160-76. [Discussion pp. 177-85]. (I-A63-13500)

1960--14TH SYMPOSIUM OF THE INTERNATIONAL ASTRONOMICAL UNION [Pulkovo, USSR, December 1960. Published in The Moon, Academic Press (1962).]

8538J "Radar Measurements of the Lunar Surface," G. H. Pettengill and J. C. Henry, pp. 519-25. (I-A63-18421)

8539J "Some Physical Constants of the Lunar Surface as Indicated by Its Radar Scattering and Thermal Emission Properties," T. B. A. Senior, K. M. Siegel, and A. Giraud, pp. 533-43. (I-A63-18423)

1961--7TH ANNUAL MEETING OF THE AMERICAN ASTRONAUTICAL SOCIETY [Dallas, Texas, 16-18 January 1961. Published in Advances in the Astronautical Sciences, Vol. 8, Plenum Press (1963).]

8540J "Wave Propagation Through a Hot Plasma," F. J. Tischer, Vol. 8, pp. 37-46. (I-A63-17623)

8541J "Radar Measurements of the Lunar Surface," G. H. Pettengill and J. C. Henry, Vol. 8, pp. 564-70. (SB-64-6594; I-A63-17662)

SYMPOSIA, CONFERENCES, CONVENTIONS, ETC. (CONT.)

1961--2ND SYMPOSIUM ON THE ENGINEERING ASPECTS OF MAGNETOHYDRODYNAMICS [Philadelphia, Pennsylvania, 9-10 March 1961. Published as Engineering Aspects of Magnetohydrodynamics, Columbia University Press (1962).]

8542J "Microwave Reflection and Absorption by a Nonuniform Plasma Sheath," L. S. Taylor, pp. 360-74. (I-A63-14044)

1961--IRE INTERNATIONAL CONVENTION [New York, New York, 20-23 March 1961.]

8543J "Enhancement of Radar Signals by Double Bounce Circular Polarization," S. Isaacson, Vol. 9, Pt. 1, pp. 10-16. (SB-62-4618)

8544J "An Active Radar Surveillance Beacon," A. R. Almond and D. F. Gumb, Vol. 9, Pt. 5, pp. 28-37. (SB-62-3228)

8545J "Gross Errors in Height Indications from Pulsed Radar Altimeters Operating Over Thick Ice or Snow," A. H. Waite and S. J. Schmidt, Vol. 9, Pt. 5, pp. 38-54. (SB-62-3214)

8546J "An Experimental Laser Ranging System," D. A. Buddenhagen, B. A. Lengyel, F. J. McClung, and G. F. Smith, Vol. 9, Pt. 5, pp. 285-90. (SB-62-3212)

8547J "Radar Target Identification by Aerial Display," R. W. Pew and J. I. Elkind, Vol. 9, Pt. 5, pp. 294-301. (SB-62-3216)

1961--SYMPOSIUM ON ELECTROMAGNETIC WAVES [Madison, Wisconsin, 10-12 April 1961. Sponsored by Mathematics Research Center, U. S. Army. Edited by R. E. Langer. Published by University of Wisconsin Press (1962).]

8548J "Electromagnetic Theory and Geometrical Optics," M. Kline, pp. 3-31. (SB-62-10926)

8549J "The Mathematical Foundations of Diffraction Theory," C. H. Wilcox, pp. 65-97. (SA-62-7740)

8550J "Function-Theoretic Aspects of Diffraction Theory," A. E. Heins, pp. 99-108. (SA-62-7741)

8551J "Abstract Operator Methods in Electromagnetic Diffraction," N. Marcuvitz, pp. 109-28. (SA-62-7742)

8552J "Diffraction by Polygonal Cylinders," J. B. Keller, pp. 129-37. (SA-62-7743)

8553J "A Mathematical Model for Diffraction by Convex Surfaces," N. A. Logan and K. S. Yee, pp. 139-80. (SA-62-7744)

8554J "The Quasi-Static Radar Cross Sections of Complex Bodies of Revolution," K. M. Siegel, pp. 181-97. (SA-62-7745)

8555J "Far Field Amplitudes and Inverse Diffraction Theory," S. N. Karp, pp. 291-300. (SA-62-7747)

8556J "Integral Equation Perturbation Methods in Low Frequency Diffraction," B. Noble, pp. 323-60. (SA-62-7748)

8557J "Scattering of Waves by Two Objects," V. Twersky, pp. 361-87. (SA-62-7749)

SYMPOSIA, CONFERENCES, CONVENTIONS, ETC. (CONT.)

1961--5th INTERNATIONAL CONFERENCE OF THE UNION OF GERMAN PHYSICAL SOCIETIES [Munich, Germany, 28 August-1 September 1961. Published in Ionization Phenomena in Gases, Vol. II, edited by H. Maecker, North Holland Publishing Co., Amsterdam (1962).]

8558J "The Incoherent Scattering of Electromagnetic Waves by Free Electrons," C. H. Papas and K. S. H. Lee, pp. 1204-13. [Discussion pp. 1214-15]. (SB-63-4905; I-A63-21912)

1961--12TH INTERNATIONAL ASTRONAUTICAL CONGRESS [Washington, D. C., 1-7 October 1961. Published by Academic Press (1963).]

8559J "Radio Characteristics of Lunar Surface Material," K. M. Siegel, Vol. II, pp. 662-69. (I-A63-21282)

1961--WISSENSCHAFTLICHE GESELLSCHAFT FUR LUFTFAHRT E. V. (WGL), TAGUNG [Freiburg, Germany, 10-13 October 1961. Published in WGL 1961 Jahrbuch, edited by H. Blenk, F. Vieweg and Son, Braunschweig (1962).]

8560J "Application of Polarization of Radar and Light Waves in the Measurement of Rotation of Missiles," H. Kleinwachter, pp. 344-46. (I-A63-21870)

1962--IRE INTERNATIONAL CONVENTION [New York, New York, 26-29 March 1962.]

8561J "Precipitation Scatter as an Interference Source in Communication Satellite Systems," A. S. Dennis, Vol. 10, Pt. 1, pp. 145-51. (SB-63-5406)

8562J "A New Approach to Radar Cross-Section Measurements," J. R. Huynen, Vol. 10, Pt. 5, pp. 3-11. (SB-63-2286; I-A63-12515)

8563J "A V.H.F. Solar Radar System," W. G. Abel, J. H. Chisholm, P. L. Fleck, and J. C. James, Vol. 10, Pt. 5, pp. 58-66. (SB-63-2290)

1962--2ND SYMPOSIUM ON PLASMA SHEATH, "ITS EFFECT UPON REENTRY COMMUNICATION AND DETECTION" [Boston, Massachusetts, 10-12 April 1962. Sponsored by U. S. Air Force Cambridge Research Laboratories, with the assistance of Lowell Technological Institute Research Foundation. Published as Electromagnetic Aspects of Hypersonic Flight, edited by W. Notman, H. K. Moore, and R. Papa, Spartan Books, Baltimore (1964).]

8564J "Scattering from Plasma Cylinders with Radial Variations in Electron Density," C. M. deRidder and S. Edelberg, pp. 286-319.

1962--3RD INTERNATIONAL SPACE SCIENCE SYMPOSIUM [Washington, D. C., 2-8 May 1962. Sponsored by Committee on Space Research (COSPAR) and U. S. National Academy of Sciences. Published as Space Research III, edited by W. Priester, Interscience Publishing Division, John Wiley and Sons (1963).]

8565J "Radar Reflections from the Sun at VHF," W. G. Abel, J. H. Chisholm, and J. C. James, pp. 635-43. (I-A63-19551)

8566J "Radar Measurements of Venus," G. H. Pettengill, pp. 872-85. (I-A63-19576)

8567J "The 1961 JPL Venus Radar Experiment," W. K. Victor and R. Stevens, pp. 886-90. (I-A63-19577)

SYMPOSIA, CONFERENCES, CONVENTIONS, ETC. (CONT.)

1962--CONFERENCE ON RADIO ASTRONOMICAL AND SATELLITE STUDIES OF THE ATMOSPHERE [Advanced Study Institute of Corfu, Corfu, Greece, June 1962. Published in Radio Astronomical and Satellite Studies of the Atmosphere, edited by J. Aarons, Interscience Publishing Division, John Wiley and Sons (1963).]

8568J "The Incoherent Scatter Technique for Studying the Earth's Atmosphere," G. H. Millman, pp. 430-52. (I-A63-25998)

1962--SYMPOSIUM ON ELECTROMAGNETIC THEORY AND ANTENNAS [Copenhagen, Denmark, 25-30 June 1962. Sponsored by URSI, Technical University of Denmark, Danish Academy of Technical Sciences, and Danish National Committee of URSI. Published as Electromagnetic Theory and Antennas, edited by E. C. Jordon, Pergamon Press (1963).]

8569J "Diffraction Theory. A Survey of Short Wavelength," J. B. Keller, pp. 3-9. (SA-64-689)

8570J "On the Transverse Diffusion of Short Waves Diffracted by a Convex Cylinder," V. Fok and L. Vainshtein, pp. 11-25. (SA-64-690)

8571J "Scalar Diffraction by a Thin Oblate Spheroid," R. F. Goodrich, N. D. Kazarinoff, and V. H. Weston, pp. 27-37. (SA-64-691)

8572J "Diffraction of a Scalar Wave by a Plane, Circular Disk," E. B. Hansen, pp. 39-43. (SA-64-692)

8573J "The Scattering of a Plane Electromagnetic Wave by a Finite Cone," C. C. Rogers, J. K. Schindler, and F. V. Schultz, pp. 67-80. (SA-64-700)

8574J "Scattering by Non-Spherical Particles Whose Size Is of the Order of the Wave Length," J. M. Greenberg, L. Libelo, A. Lind, and R. T. Wang, pp. 81-92. (SB-63-10075)

8575J "Plane Wave Diffraction by a Strip," R. E. Kleinman, pp. 97-103. (SA-64-693)

8576J "Scattering by a Wide Grating," R. F. Millar, pp. 105-08. (SA-64-703)

8577J "A Boundary Wave Theory of Diffraction at an Aperture," E. Wolf, E. Marchand, and K. Miyamoto, pp. 109-11. (SA-64-694)

8578J "Diffraction Wave in Case of an Arbitrary Incident Field in the Electromagnetic Kirchhoff Theory," A. Rubinowicz, pp. 113-18. (SA-64-695)

8579J "The Radar Cross-Section of a Conducting Cylinder with Dielectric Sleeve: Optical Limit," R. D. Kodis, pp. 127-32. (SB-63-13975)

8580J "Scattering from a Cylinder Coated with a Dielectric Material," C. W. Helstrom, pp. 133-44. (SA-64-705)

8581J "Scattering by a Finite Cylinder," R. B. Kieburtz, pp. 145-56. (SA-64-706)

8582J "The Diffraction Fields of the Non-Uniform Circular Aperture," S. Cornbleet, pp. 157-75. (SA-64-697)

8583J "Some Recent Developments in Scattering and Diffraction Theory," A. E. Heins, pp. 185-86. (SA-64-707)

8584J "Systematic Improvement of Quasistatic Calculations," S. N. Karp, pp. 205-07. (SB-63-13196)

8585J "Scattering Diagrams in Electromagnetic Theory," G. A. Deschamps, pp. 235-52. (SA-64-708)

SYMPOSIA, CONFERENCES, CONVENTIONS, ETC. (CONT.)

1962--SYMPOSIUM ON ELECTROMAGNETIC THEORY AND ANTENNAS (CONT.)

8586J "Impedances and Reflection Coefficients for Anistropic Media," I. Kay, pp. 375-90. (SA-64-686)

8587J "A Note on the Oblique Incidence of Electromagnetic Waves Upon an Absorbing Slab," K. Morita, pp. 625-34. (SA-64-3150)

8588J "Delineation of Problems and Methodology in the Subject of Scattering by a Statistically Inhomogeneous Medium," S. Silver, pp. 661-64. (SA-64-5813)

8589J "Scattering by a Perturbed Continuum," H. Bremmer, pp. 665-700. (SA-64-3179)

8590J "Scattering by Random Media," V. Twersky, pp. 701-16. (SB-64-687)

8591J "The Depolarisation of Electromagnetic Waves Scattered from Rough Surfaces," P. Beckmann, pp. 717-26. (SB-64-688)

8592J "Study of Reflections from the Sea by Means of a Goniometer," L. Boithias, A. Spizzichino, and C. Taieb, pp. 763-70. (SA-64-5805)

8593J "Partially Coherent Diffraction by a Circular Aperture," R. A. Short, pp. 787-96. (SA-64-3147)

8594J "Polarization Properties of the Electromagnetic Field Diffracted from an Aperture," B. Karczewski and E. Wolf, pp. 797-800. (SA-64-5810)

8595J "Diffraction of Fluctuating Fields. Review of Soviet Papers," N. G. Denisov and L. S. Dolin, pp. 819-36. (SB-64-692)

8596J "Propagation of Electromagnetic Waves Along Unidirectionally Conducting Screens," F. C. Karal, Jr., and S. N. Karp, pp. 967-80. (SA-64-3175)

1962--INTERNATIONAL CONFERENCE ON THE IONOSPHERE [London, England, July 1962. Sponsored by Institute of Physics and Physical Society.]

8597J "The Radio Aurora in High Latitudes," K. Bullough, pp. 151-54. (SA-63-13806)

8598J "Backscatter Study of Ionospheric Irregularities by Using a Vertically Split Beam," I. Ranzi, pp. 285-87. (SA-63-13726; I-A63-16064)

8599J "Some Recent Observations of Ionospheric Backscatter at 300 Mc/s," J. S. Greenhow, H. K. Sutcliffe, and C. D. Watkins, pp. 288-92. (SA-63-13717; I-A63-16065)

8600J "The Amplitude and Spectrum of Ground Backscatter Echoes," E. D. R. Shearman, pp. 293-300. (SA-63-13718; I-A63-16066)

8601J "The Interpretation of Meteor Echoes Observed at a Frequency of 300 Mc/s," J. S. Greenhow and C. D. Watkins, pp. 336-41. (SB-63-10678; I-A63-16073)

8602J "The Reflection of a Pulse at an Epstein Profile," C. Fengler, pp. 400-05. (I-A63-16080)

8603J "Radio Wave Reflections at a Continuously Stratified Plasma with Collisions Proportional to Energy and Arbitrary Magnetic Induction," J. R. Johler, pp. 436-45. (I-A63-16085)

SYMPOSIA, CONFERENCES, CONVENTIONS, ETC. (CONT.)

1962--INTERDISCIPLINARY CONFERENCE ON ELECTROMAGNETIC SCATTERING [Potsdam, New York, August 1962. Published as Electromagnetic Scattering, edited by M. Kerker, Pergamon Press (1963).]

8604J "Scattering of Short Waves," J. B. Keller and B. R. Levy, pp. 3-24. (SA-64-19226)

8605J "Light Scattering from Objects with Spherical Symmetry," P. J. Wyatt, pp. 25-35. (SA-64-14396)

8606J "Scattering of Electromagnetic Waves from Two Concentric Spheres, When Outer Shell Has a Variable Refractive Index," S. Levine and M. Kerker, pp. 37-46. (SA-64-14393)

8607J "Extension of the Rayleigh-Gans Theory," Y. Ikeda, pp. 47-53. (SA-64-14394)

8608J "Scattering by Infinite Cylinders at Perpendicular Incidence," W. A. Farone, M. Kerker, and E. Matijevic, pp. 55-71. (SA-64-14395)

8609J "Scattering Diagrams in the Mie Region," R. Penndorf, pp. 73-86. (SA-64-14891)

8610J "Mie Scattering of an Atmospheric Air Volume," K. Bullrich, pp. 191-207. (SA-64-15871)

8611J "Back-Scatter by Dielectric Spheres With and Without Metal Caps," D. Atlas and K. M. Glover, pp. 213-36. (SA-64-14895)

8612J "Surface Waves Associated with the Backscattering of Microwave Radiation by Large Ice Spheres," J. R. Probert-Jones, pp. 237-50. (SA-64-19230)

8613J "Calculations of the Total Attenuation and Angular Scatter of Ice Spheres," B. M. Herman and L. J. Battan, pp. 251-59. (SA-64-14896)

8614J "The Role of Radio Wave Scattering in the Study of Atmospheric Microstructure," R. Bolgiano, Jr., pp. 261-67. (SA-64-15874)

8615J "Recent Progress in the Development of a New Approximate General Theory of Multiple Scattering," C. C. Grosjean, pp. 485-506. (SA-64-14018)

8616J "A Variable-Order Diffusion-Type Approximation for Multiple Scattering," C. M. Chu, S. W. Churchill, and S. C. Pang, pp. 507-22. (SA-64-14019)

8617J "Multiple Scattering of Waves in Dense Distributions of Large Tenuous Scatterers," V. Twersky, pp. 523-46. (SA-64-14020)

8618J "Multiple Scattering in Media with Anisotropic Scattering," Z. Sekera, pp. 547-57. (SA-64-14088)

8619J "Numerical Solutions for Multiple, Anisotropic Scattering," C. M. Chu, J. A. Leacock, J. C. Chen, and S. W. Churchill, pp. 567-82. (SA-64-14089)

1962--13TH INTERNATIONAL ASTRONAUTICAL CONGRESS [Varna, Bulgaria, September 1962. Published by Springer-Verlag (1964).]

8620J "Enhancement of Radar Reflectivity Associated with the Lunar Crater Tycho," G. H. Pettengill and J. C. Henry, Vol. I, pp. 38-41. (I-A64-28435)

1962--NATIONAL ELECTRONICS CONFERENCE [Chicago, Illinois, 8-10 October 1962.]

8621J "Asymmetrical Scattering from a Ferrite Cylinder," J. C. Palais, Vol. 18, pp. 141-58. (SB-64-701)

SYMPOSIA, CONFERENCES, CONVENTIONS, ETC. (CONT.)

1962--WISSENSCHAFTLICHE GESELLSCHAFT FUR LUFT- UND RAUMFAHRT E. V. (WGLR), JAHRESTAGUNG [Braunschweig, Germany, 9-12 October 1962. Published as WGLR 1962 Jahrbuch, edited by H. Blenk, F. Vieweg and Son, Braunschweig (1963).]

8622J "Statistical Behavior of Aircraft Radar Echoes," M. Vogel, pp. 461-69. [Discussion p. 469]. (I-A64-27011)

1963--WAVE INTERACTION AND DYNAMIC NONLINEAR PHENOMENA IN PLASMAS [Pennsylvania State University, University Park, Pennsylvania, 4-6 February 1963.]

8623J "Electromagnetic Nonlinear Interaction and Reflection from a Plane Ionized Medium," O. E. H. Rydbeck, pp. 3-41. (SA-64-27665)

1963--IEEE INTERNATIONAL CONVENTION [New York, New York, 25-28 March 1963.]

8624J "Scattering of High-Frequency Waves by Perfectly Conducting Rectangular Cylinders," K. Mei, Vol. 11, Pt. 1, pp. 132-36. (SB-64-696)

1963--NATO ADVANCED STUDY INSTITUTE [Skeikampen, Norway, 17-26 April 1963. Published as Electron Density Distribution in Ionosphere and Exosphere, edited by E. Thrane, Interscience Publishing Division, John Wiley and Sons (1964).]

8625J "Ionosonde Studies of Some Chemical Releases in the Ionosphere," J. W. Wright, pp. 116-37. (I-A64-27655)

8626J "Method for Determining the True Reflection Heights in the Ionosphere from Parameters Taken from Ionograms," C. Taieb, pp. 138-51. [In French]. (I-A64-27656)

1963--16TH SYMPOSIUM IN APPLIED MATHEMATICS, "STOCHASTIC PROCESSES IN MATHEMATICAL PHYSICS AND ENGINEERING" [New York, New York, 30 April-2 May 1963. Sponsored by American Mathematical Society and Society for Industrial and Applied Mathematics. Edited by R. Bellman. Published by American Mathematical Society, Providence (1964).]

8627J "On Propagation in Random Media of Discrete Scatterers," V. Twersky, pp. 84-116. (I-A65-23366)

1963--4TH INTERNATIONAL SPACE SCIENCE SYMPOSIUM [Warsaw, Poland, 3-12 June 1963. Sponsored by Committee on Space Research (COSPAR). Published as Life Sciences and Space Research II, edited by M. Florkin and A. Dollfus, Interscience Publishers (1964).]

8628J "Study of Wind Shear in the Lower Ionosphere from Radioelectric Observation of Meteor Trails [Appendix - Calculation of the Difference Effect]," F. du Castel, I. Revah, and A. Spizzichino, 18 pp. (I-A63-22780)

8629J "Radar Observations of Venus in the Soviet Union in 1962," O. N. Rzhiga, pp. 178-89. (I-A64-24958)

8630J "Radar Observations of the Planet Mars in the Soviet Union," A. M. Shakhovskoi, pp. 255-57. (I-A64-24968)

1963--8TH MEETING OF THE AGARD IONOSPHERIC RESEARCH COMMITTEE [Athens, Greece, July 1963. Published as Arctic Communications (AGARDograph No. 78), edited by B. Landmark, Pergamon Press (1964).]

8631J "Backscatter Observations at Lindau-Harz with Variable Frequency Directed to the Auroral Zone," H. G. Moller, pp. 177-88. (I-A65-12197)

SYMPOSIA, CONFERENCES, CONVENTIONS, ETC. (CONT.)

1963--5TH INTERNATIONAL SYMPOSIUM ON SPACE TECHNOLOGY AND SCIENCE [Tokyo, Japan, 2-7 September 1963. Edited by T. Hayashi.]

8632J "On the Effect of Wrinkles on the Reflections by a Sphere," F. J. Tischer, pp. 745-50. (I-A65-14346)

1963--7TH NATIONAL CONVENTION ON MILITARY ELECTRONICS [Washington, D. C., 9-11 September 1963. Sponsored by IEEE Professional Group on Military Electronics.]

8633J "An Airborne, Four-Frequency, Frequency Stabilized, Coherent Radar System," N. G. Hamm, E. G. McCall, F. C. Macdonald, and J. T. Ransone, Jr., pp. 57-59. (I-A64-22486)

8634J "Dynamic Radar Cross-Section Predictions," J. R. Huynen, pp. 83-85. (I-A64-22491)

1963--21ST ANNUAL AEROSPACE ELECTRICAL/ELECTRONICS CONFERENCE [Aerospace Electrical Society, Los Angeles, California, 9-11 October 1963. Published by Western Periodicals Co., North Hollywood (1963).]

8635J "Studies in Radar Cross Section Measurements," P. H. Ware and K. H. Schetne, pp. 195-216. (I-A64-17252)

1963--NATIONAL ELECTRONICS CONFERENCE [Chicago, Illinois, 28-30 October 1963.]

8636J "The Dielectric Rod as an Unusually Effective Radar Reflector," D. D. Howard and N. A. Thomas, Vol. 19, pp. 72-78. (SB-64-15950)

8637J "Scattering of Electromagnetic Radiation by Ionized Gases," O. H. Theimer, Vol. 19, pp. 661-67. (SB-64-15736)

1963--NORTHEAST ELECTRONICS RESEARCH AND ENGINEERING MEETING (NEREM) [Boston, Massachusetts, 4-6 November 1963.]

8638J "Polarization Techniques and Components for Radar and Communication Systems," P. J. Allen and R. D. Tompkins, pp. 16-17.

1964--1ST LOCKHEED RESEARCH SYMPOSIUM ON SPACE SCIENCE, "AURORAL PHENOMENA" [January 1964. Edited by M. Walt. Published by Stanford University Press and Oxford University Press (1965).]

8639J "Electromagnetic Measurements of Auroras," R. L. Leadabrand, pp. 99-129. (I-A65-19098)

1964--5TH NATIONAL WINTER CONVENTION ON MILITARY ELECTRONICS [Los Angeles, California, 5-7 February 1964. Sponsored by IEEE Professional Group on Military Electronics. Published by Western Periodicals Co., North Hollywood (1964).]

8640J "Radar Applications of the Laser," D. L. Creed, Vol. 3, pp. 17-7 to 17-14. (I-A64-21618)

1964--IEEE INTERNATIONAL CONVENTION [New York, New York, 23-26 March 1964.]

8641J "On Processing the Radar Return from an Ionized Trail," W. Gersch, Vol. 12, Pt. 2, pp. 227-34. (SB-65-3263; I-A64-22443)

8642J "The Optimum Allocation of Mass in Dispersed Reflector Clusters," N. S. Potter, Vol. 12, Pt. 6, pp. 62-70. (SB-65-8647)

SYMPOSIA, CONFERENCES, CONVENTIONS, ETC. (CONT.)

1964--IEEE INTERNATIONAL CONVENTION (CONT.)

8643J "A High Resolution, Microwave Modulated Optical Doppler Radar," R. B. Hankin and A. C. Todd, Vol. 12, Pt. 7, pp. 246-51. (SB-65-6621)

1964--NATIONAL AEROSPACE ELECTRONICS CONFERENCE [Dayton, Ohio, 11-13 May 1964. Sponsored by IEEE Professional Group on Aerospace and Navigational Electronics, Dayton Section of IEEE, and American Institute of Aeronautics and Astronautics. Published by Dayton Section of IEEE (1964).]

8644J "The Nature and Correction of Doppler Radar Errors Over Water," W. R. Fried and J. A. Losier, pp. 277-85. (I-A65-24134)

1964--SYMPOSIUM ON QUASI-OPTICS [Polytechnic Institute of Brooklyn, 8-10 June 1964. Sponsored by Polytechnic Institute of Brooklyn, IEEE, Optical Society of America, U. S. Air Force, Army, Navy. Edited by J. Fox. Published by Polytechnic Press, Brooklyn (1964).]

8645J "Quasi-Optic Diffraction," L. B. Felsen, pp. 1-40. (SB-65-7651)

8646J "The Progressing Wave Formalism," R. M. Lewis, pp. 71-103. (SA-65-10223)

8647J "Diffraction by Objects in Anisotropic Media," B. Rulf and L. B. Felsen, pp. 107-47. (SA-65-10539)

8648J "Diffraction Anomalies with Millimetric Wave Gratings," C. H. Palmer, Jr., pp. 151-62. (SA-65-10540)

8649J "Some Limitations on Spherically Symmetric Lenses for Use as Passive Reflectors," I. Kay, pp. 165-75. (SB-65-7646)

8650J "Semi-Geometric-Optical Approaches to Scattering Phenomena," H. Bremmer, pp. 415-35. (SA-65-10224)

8651J "The Meaning of Reflection Coefficient and Its Application to Lunar and Planetary Radar Experiments," K. M. Siegel, pp. 439-44. (SA-65-10536; I-A65-16762)

1964--SOLAR SYSTEM RADIO ASTRONOMY [NATO Advanced Study Institute of the National Observatory of Athens, Cape Sounion, Greece, 2-15 August 1964. Edited by J. Aarons. Published by Ionospheric Institute of the National Observatory, Athens (1965).]

8652J "Radar Astronomy of Solar System Plasmas," V. R. Eshleman, pp. 267-93. (I-A65-27034)

8653J "Lunar Radar Reflections," G. Pettengill, pp. 355-69. (I-A65-27036)

8654J "Planetary Radar Astronomy," G. Pettengill, pp. 401-11. (I-A65-27038)

1964--WORLD CONFERENCE ON RADIO METEOROLOGY (INCORPORATING THE 11TH WEATHER RADAR CONFERENCE) [Boulder, Colorado, 14-18 September 1964.]

8655J "Angels in Focus," D. Atlas, pp. 2-5. (I-A65-11983)

8656J "On Sea Breeze 'Angels,'" S. G. Geotis, pp. 6-9. (I-A65-11984)

8657J "Radar and Refractometer Investigation of Clear-Air Stratification," D. R. Hay, pp. 10-12. (I-A65-11985)

8658J "Occurrence and Characteristics of Radar Angels Observed with a Vertically-Pointing Pulse Radar," H. Ottersten, pp. 22-27. (I-A65-11987)

SYMPOSIA, CONFERENCES, CONVENTIONS, ETC. (CONT.)

1964--WORLD CONFERENCE ON RADIO METEOROLOGY (INCORPORATING THE 11TH WEATHER RADAR CONFERENCE) (CONT.)

8659J "A Theory of Offshore Radar Angels," D. B. Rai, pp. 28-33. (I-A65-11988)

8660J "Hydrodynamic Vortex Seen by Radar," W. Schnapauff, pp. 34-35. (I-A65-11989)

8661J "Three Dimensional Analysis of a Precipitation-Free, Sea-Breeze Front by Radar, Tiros, Visual, and Mesosynoptic Data," H. V. Senn and H. P. Gerrish, pp. 36-41. (I-A65-11990)

8662J "On the Inference of Atmospheric Refractive Index Profiles from Observations of Radar Angels," P. L. Smith, Jr., pp. 42-45. (I-A65-11991)

8663J "A Survey of Five Radar Remote Measurement Techniques to Measure the Particle Drop Size Distribution of Water Clouds and Rains," J. E. Bridges, pp. 130-35. (I-A65-12003)

8664J "A Study of Raindrop Size Distributions in the Free Atmosphere," P. G. F. Caton, pp. 136-41. (I-A65-12004)

8665J "Z-R Equation in Various Storms," M. Fujiwara, pp. 154-57. (I-A65-12005)

8666J "An Extension of the Z-R Relation for Doppler Radar," R. R. Rogers, pp. 158-61. (I-A65-12006)

8667J "Complete Scattering Parameters of Polydispersed Hydrometeors in the λ 0.1 to λ 10 Cm Range," D. Deirmendjian, pp. 172-76. (I-A65-12007)

8668J "The Effects of Multiple Scattering on Radar Backscattering," B. M. Herman, pp. 182-87. (I-A65-12008)

8669J "Observations of the Ellipticity of Raindrops Using a Polarized Radar System," M. C. Hodson and T. V. Peter, pp. 188-91. (I-A65-12009)

8670J "Scattering of Microwaves by Adjacent Water Droplets in Air," O. Lillesaeter, pp. 192-93. (I-A65-12010)

8671J "A Study of the Radar Precipitation Attenuation as Deduced from Drop Size Distributions," E. A. Mueller, pp. 194-97. (I-A65-12011)

8672J "Scattering of Microwaves by Cloud Droplets," P. L. Smith, Jr., pp. 202-07. (I-A65-12013)

8673J "Radar Reflections from Acoustic Shock Waves--A Preliminary Study," C. H. Allen and S. D. Weiner, pp. 270-73. (I-A65-12026)

8674J "Wind Measurement by Conventional Radar with a Dual Beam Pattern," D. Atlas and R. Wexler, pp. 274-77. (I-A65-12027)

8675J "Improvement in Accuracy of Thunderstorm Echo Top Measurement," R. J. Donaldson, Jr., pp. 288-91. (I-A65-12031)

8676J "The Equivalent Height for Reflection of Radio Waves from Tropospheric Layers," C. Fengler, pp. 432-39. (I-A65-12043)

8677J "Reflection Against Inclined Layers," C. Fengler, pp. 446-49. (I-A65-12045)

8678J "Isotropy Properties of the Tropospheric Refractive Index and Air Velocity Fields as Determined by Radio Methods," D. T. Gjessing, pp. 450-53. (I-A65-12046)

8679J "Meteorological Observations with Lidar," M. G. H. Ligda, pp. 482-89. (I-A65-12051)

SYMPOSIA, CONFERENCES, CONVENTIONS, ETC. (CONT.)

1964--WORLD CONFERENCE ON RADIO METEOROLOGY (INCORPORATING THE 11TH WEATHER RADAR CONFERENCE) (CONT.)

8680J "The Use of Coherent Light in Gathering Significant Meteorological Data," R. H. McFarland, pp. 494-97. (I-A65-12052)

8681J "Experimental Evidence for a Layered Structure in the Stratosphere," A. Villevieille, pp. 498-503. (I-A65-12053)

1964--1ST INTERNATIONAL CONGRESS ON INSTRUMENTATION IN AEROSPACE SIMULATION FACILITIES (INTERCON) [Paris, France, 28-29 September 1964.]

8682J "Millimeter Radar Instrumentation for Studying Plasma Effects Associated with Hypersonic Flight," H. M. Musal, Jr., R. I. Primich, W. E. Blore, and P. E. Robillard, pp. 7-1 to 7-13. (I-A64-28111)

1964--CONFERENCE ON LASERS AND THEIR APPLICATIONS [London, England, 29 September-1 October 1964. Sponsored by Institution of Electrical Engineers.]

8683J "Fundamentals of Laser Ranging," I. L. Davies and R. Meredith, pp. 22-1 to 22-2. (I-A65-12369)

8684J "The Propagation of Infra-Red Radiation Through the Lower Atmosphere," J. MacDowall, pp. 49-1 to 49-8. (I-A65-12393)

1964--NATIONAL ELECTRONICS CONFERENCE [Chicago, Illinois, 19-21 October 1964.]

8685J "A New Reflection Coefficient for Low Density Dielectrics," M. A. Plonus, Vol. 20, pp. 14-16. (I-A65-11315)

BOOKS, MONOGRAPHS, ETC.

8686J "Radio Wave Propagation and the Ionosphere," Ya. L. Al'pert, 394 pp., Consultants Bureau, New York (1963).

8687J "Radio Surface Waves," H. M. Barlow and J. Brown, 200 pp., Oxford University Press (1962).

8688J "Radar System Analysis," D. K. Barton, 608 pp., Prentice-Hall (1964).

8689J "Radar Meteorology," L. J. Battan, 161 pp., University of Chicago Press (1959).

8690J "The Scattering of Electromagnetic Waves from Rough Surfaces," P. Beckmann and A. Spizzichino, 503 pp., Pergamon Press (1963).

8691J "Diffraction of Electromagnetic Waves by a Disk," M. G. Belkina, in monograph: Diffraction of Electromagnetic Waves on Certain Bodies of Rotation, edited by V. A. Fok, M. G. Belkina, and L. A. Vainshtein, 209 pp., Moscow (1957). [Trans: LC or SLA 60-13691]. (TT-60/1-60-13691)

8692J "Radio Wave Scattering in the Ionosphere," K. L. Bowles, in Advances in Electronics and Electron Physics, Vol. 19, pp. 55-176, Academic Press (1964). (I-A64-24166)

8693J "The Scattering Properties of the Lunar Surface at Radio Wave Lengths," J. V. Evans and G. H. Pettengill, in The Solar System, Vol. 4: The Moon, Meteorites, and Comets, edited by B. M. Middlehurst and G. P. Kuiper, pp. 129-61, University of Chicago Press (1963).

BOOKS, MONOGRAPHS, ETC.

8694J "Propagation of Electromagnetic Waves in Plasmas," V. L. Ginzburg, translated from the Russian by Royer and Roger, edited by W. L. Sadowski and D. M. Gallik, 822 pp., Gordon and Breach (1961).

8695J "Propagation of Electromagnetic Waves in Plasmas," V. L. Ginzburg, 535 pp., Pergamon Press (1964).

8696J "Theory of Diffraction," H. Honl, A. W. Maue, and K. Westpfahl, in Handbuch der Physik, Vol. XXV, Pt. 1, pp. 218-573, Springer-Verlag (1961).

8697J "Radio Echoes from Sun, Moon and Planets," F. J. Kerr, in Handbuch der Physik, Vol. LII, pp. 449-64, Springer-Verlag (1959). (MG-60-11H-73)

8698J "The Scattering and Diffraction of Waves," R. W. P. King and T. T. Wu, 218 pp., Harvard University Press (1959).

8699J "The Kirchhoff-Young Theory of Diffraction of Electromagnetic Waves," O. Laporte and J. Meixner, unidentified monograph, 31 pp., Aachen (no date). [Trans: SLA-59-20681]. (TT-60/1-59-20681)

8700J "Radargrammetry," D. Levine, 330 pp., McGraw-Hill (1960).

8701J "Tables of Light Scattering Functions for Spherical Particles," W. J. Pangonis, W. Heller, and A. Jacobson, 116 pp., Wayne State University Press, Detroit (1957).

8702J "Angular Scattering Functions for Spherical Particles," W. J. Pangonis and W. Heller, 222 pp., Wayne State University Press, Detroit (1960).

8703J "Introduction to Radar Systems," M. I. Skolnik, 648 pp., McGraw Hill (1962).

8704J "On Radio Reflections from the E- and D-Levels During Auroral Activity," W. Stoffregen, in Annals of the International Geophysical Year, Vol. 11, pp. 127-33, Pergamon Press (1961). (I-62-5051; MG-62-13.9-224)

8705J "Diffraction of Electromagnetic Waves," L. A. Vainshtein, Chap. 15 (61 pp.) of Elektromagnitnyye Volny, Moscow (1957). [Trans: LC or SLA 59-20630]. (TT-60/1-59-20630)

8706J "Light Scattering by Small Particles," H. C. Van de Hulst, 470 pp., John Wiley (1957). (ET-59-1519)

8707J "Electromagnetic Waves in Stratified Media," J. R. Wait, 372 pp., Pergamon Press (1962).

GUIDE TO USE OF THE BIBLIOGRAPHY

Organization of Material

This bibliography is divided into volumes on the basis of security classification. Abstracts of Unclassified documents appear in Volume VII, and those of Confidential documents in Volume VIII. Volume IX primarily contains abstracts of Secret documents, and Volume X those classified Secret-Restricted data, together with abstracts of lower classification unsuitable for the other volumes due to special distribution limitations.

Within each volume, report abstracts are grouped according to the originating source (not the issuing agency if different from the source), and the sources are arranged alphabetically. Within a source group, abstracts are arranged according to the most logical scheme apparent in each case. Some sources consistently apply overall or departmental serial numbers to all reports, and these sequences have normally been followed when available. Lacking such a sequence, reports are often in blocks according to project or contract, and these blocks are arranged chronologically by date of the first report. Miscellaneous abstracts are placed at the beginning or end of the source group. Straight chronological sequence has sometimes been followed in the absence of clearly defined series, particularly where only a few isolated reports are included for a source.

Entries for journal articles are found in Volume VII following the report abstracts. They are grouped alphabetically by journal name, and ordered chronologically within each journal group. Conference records and books are listed at the end of this section.

Abstract Numbering Scheme

Each abstract in the entire ten-volume bibliography bears a unique identifying serial number. For convenience in determining which volume a specified abstract is in, the numbers were assigned in blocks, according to the following tabulation.

Volume	Date	Class.	Contents
I	1952	U	Index to Vols. II and III
II	1952	C	Abstracts 1-967
III	1952	S	Abstracts 1001-1189
IV	1958	U	Index to Vols. V and VI
V	1958	C	Abstracts 2001-2770 and 3001J-3427J
VI	1958	S	Abstracts 4001-4378
VII	1967	U	Abstracts 5001-6321 and 7001J-8707J; Index to Vols. VII-X
VIII	1967	C	Abstracts 9001-9755
IX	1967	S	Abstracts 10001-10716
X	1967	SRD	Abstracts 11001-11375

Abstract Headings

Bibliographic information about the document is summarized in a heading preceding the abstract itself. The format used is illustrated by the following example for the Aerospace Corporation.

5016 Report TDR-469(S5855-30)-1 (BSD-TR-64-152), "Wake Radar Cross Section of Slender Re-Entry Vehicles," F. L. Fernandez, J. L. Carson, and D. A. Anderson, AF 04(695)-469, Oct 64, (51:-), Unclassified, AD 450 601L. (Release only to Department of Defense agencies is authorized. Other certified requestors shall obtain release approval from Ballistic Systems Division, Norton AFB, California, Attn: BSYDF.)

The separate items in the heading are discussed below in the order in which they appear. When an item is unknown or inapplicable, it is simply omitted from the heading.

(1) Abstract Number. This is Abstract 5016; according to the tabulation above, it appears in Volume VII.

(2) Primary Identification. The chief identification number assigned by the originating source (Aerospace Corporation): Report TDR-469(S5855-30)-1. Frequently, but by no means invariably, the ordering of abstracts within a source is in accordance with primary report numbers.

(3) Secondary Identification. This report is also given the designation BSD-TR-64-152, identifying it as Technical Report 64-152 of the Ballistic Systems Division, Air Force Systems Command. Such secondary identifications are often applied by military sponsors; they appear within parentheses following the primary identification. Additional source-applied report designations may also be placed in parentheses after the primary one.

(4) Title. The title is placed in quotes. For a classified report, the classification of the title itself is indicated by a letter in parentheses after the title: U = Unclassified; C = Confidential; S = Secret. NV = "not verified" and signifies that the title classification was not marked on the document; in such a case, the title must be presumed to bear the same classification as the report itself unless positively known otherwise. An asterisk after the letter, e.g., U*, means the classification was applied to the title by DDC but was not marked on the document by the originator. Title style follows our original source.

(5) Author(s). In cases of multiple authors, up to four are listed; for five or more, the first three are listed with "et al."

(6) Contract Number. Given when known for documents generated under government contract.

(7) Date of report.

(8) Pages:References. The number of pages and the number of references are shown in parentheses. In the example, (51:-) means 51 pages and the number of references not known or not suitably arranged for easy counting.

(9) Classification of report; plus downgrading group number if classified.

(10) DDC Document Number. In this case, the letter "L" following the AD number signifies that distribution is limited. Qualified requestors can obtain copies of documents from the Defense Documentation Center with only this number for identification. The expression "DDC Ref. Only" following the AD number means the document can only be examined at a DDC office and cannot be supplied to patrons. See also next item.

(11) Distribution Limitations. When known, any limitations on distribution of the document by DDC or otherwise are stated after the AD number, as in the example. It has not been practical to routinely update the addresses of sources given in DDC distribution-limitation statements and they are generally repeated in the form they took on the document or in the DDC listing.

Some abstracts pertain to a series or group of reports rather than a single one. In such cases, the heading contains those facts that are common to all the reports, and facts concerning individual reports are tabulated below the heading.

Symposium proceedings are usually handled with the proceedings volume itself described in a regular numbered abstract, and each pertinent paper described in subsequent numbered abstracts. An example of such a heading format follows.

5919 Paper in [the report of] Abstract 5908. "Sub-Nanosecond Pulse Methods of Radar Cross Section Measurement," R. R. Hively (Micronetics, Inc.), (10:15), Unclassified.

As this example illustrates, besides giving reference to the abstract describing the proceedings volume itself, the heading gives the paper title, author, author's affiliation if known, pages and references, and classification. The date is that of the symposium proceedings and is not repeated.

In some cases, symposium papers are not given individual numbered abstracts but are merely listed in a single abstract, or described (within a single numbered abstract) under sub-abstract headings closely similar in form to those illustrated above.

Nature of the Abstracts

Abstracts vary greatly in length as well as in form and content. These differences derive partially from the disparate nature of the documents described, but also reflect differences in treatment by different abstractors which were not wholly removed in editing. Where possible, the aim has been to furnish an "informative" abstract of each report, summarizing important results, conclusions, theorems proved, etc. With many reports, this was not practicable due to the nature of the report itself. In these cases, we have usually prepared a "descriptive" abstract of the significant contents. In both cases, we have attempted to provide enough information in the abstract so that a user with only limited interest may not need to acquire the document itself, while a user with greater interest can determine whether or not he needs the document.

Particular attention has been given to noting the presence of short, self-contained studies on special topics such as often appear in appendices. These are frequently discussed in sub-abstracts, and are covered in both subject and author indices as appropriate.

When the authors' abstracts adequately fulfilled the above aims, they have been used either directly or with editing. Most of abstracts, however, have been prepared especially for this bibliography.

We have tried to limit the body of the abstracts to objective discussion of report nature and contents. Normally, subjective opinions and comments are given as Editor's Notes (marked as "Ed:"). Other, non-subjective explanatory items are marked as "Note:".

For some entries, the abstract says, in essence, that the report is not pertinent to radar reflectivity. These abstracts should alert the reader to the fact that either the title, a DDC descriptor, or some other indicator has been misleading in suggesting that pertinent material is actually contained in the report. In some other cases, non-pertinent items are included for completeness in an otherwise pertinent series of documents.

Cross-References in Abstracts

Cross-references are sometimes made to point out comparable, related, or supplementary work discussed in other abstracts. Since this could not be done comprehensively, the reader should normally expect to use the Subject Index as a guide to such other work. Also, material is sometimes published in two or more forms. When such duplication is between reports of the same source (as with quarterly and final reports on a program), we have frequently called it to the reader's attention. Where we have noticed duplication between reports issued from different sources, mention is made in one or both of the abstracts. The common existence of duplication between reports and journal articles can generally be determined through the Author Index.

Documents Not Obtained

When a report, known or thought to be pertinent, was not obtained for abstracting, the heading includes all available information. If no abstract could be obtained, the entry is merely marked: "Note: This report was not obtained," or DDC Descriptors are listed. If, however, an abstract was available, it has been edited and used with a notation to indicate the source of the abstract. Such secondary abstracts were obtained from DDC, from the Batelle-Defender Information Analysis Center at Batelle Memorial Institute, and from Recon Central at the Air Force Avionics Laboratory. DDC abstracts are identified by preceding the abstract with "(DDC)." Those obtained from Battelle-Defender are marked with their accession number for the document, e.g., (BD-5649). Abstracts from Recon Central are similarly marked, e.g., (RC-000261); most of these Recon Central abstracts were obtained by them from DDC.

Since abstracts from secondary sources were not drawn up with the specialized subject interest of this bibliography in mind, all pertinent material may not be mentioned. Battelle-Defender material also varies considerably in nature. Sometimes it comprises the author's abstract or a portion thereof, but is often an extract quoted from the report, or merely the table of contents. Particularly in these latter cases, it is quite likely that the presence of pertinent reflectivity material in the report is not fully indicated.

Journal Entries

Since most pertinent journals are widely available in technical libraries, journal articles are listed without abstracts. The entries normally include title, author, and standard bibliographic reference data. An abstract number is commonly given for one or more of the following abstract services: (1) International Aerospace Abstracts, (2) Science Abstracts, Series A, (3) Science Abstracts, Series B, (4) Electronic Technology, and (5) Technical Translations. Abstract numbers of these services are identified, respectively, by the prefixes I, SA, SB, ET, and TT. If the last two digits of the year in which the abstract appeared are not already a part of the serial number, they follow the applicable prefix.

Symbols and Abbreviations

Journal names have frequently been abbreviated in references, using the standard forms employed in Science Abstracts. As a general practice, terms and symbols used by the authors are preserved in the abstracts. Definitions and explanations of unorthodox symbols and terms have been supplied whenever it was felt desirable, unless lacking in the abstracted document itself. Standard abbreviations for units are used freely without definition, since it was felt they are familiar to virtually all readers. Selected symbols and abbreviations are tabulated for reference in the accompanying list.

Source Index

Corporate sources originating documents are listed alphabetically in the Source Index. Opposite each name is cited the initial page number for the associated group of abstracts in each of Volumes VII, VIII, IX, and X. A vast number of changes have taken place in the designations of companies and government agencies before, during, and after the time period of the bibliography. Rather than attempt to trace through all such evolving organizational names, we have normally listed documents under the name prevailing at the time they were issued. In some cases, where the changes were relatively simple and evident, all documents are listed under the most recent source designation. A limited number of cross-references are made in the Source Index.

Author Index

Names of authors of abstracted material are arranged alphabetically in the Author Index, together with the abstract numbers of their work. When a document has multiple authors, all names are included if the number is four or less. When there are five or more authors, only the first three are listed in the abstract heading (with "et al.") and indexed.

The large number of Russian journals and translations included in these volumes of the bibliography has introduced a problem since authors' names have been transliterated according to several different systems. The usual policy has been to follow whatever system was used by the source in each instance. Unfortunately, the name of an individual author is often transliterated in two or more ways on different articles. Insofar as possible, we have attempted to index all abstracts of a single person under one form of his name, but it is probable that some blunders occurred in this process.

A similar but less severe problem arises from instances where an author has published works under different forms of his name, for example, single initial, double initial, full name, Jr. omitted or included, etc. All strongly similar names were checked and available evidence scanned to determine whether the identity was single or double; when doubt remained, the entries were left in separate form.

Subject Index

The Subject Index comprises an alphabetical listing of topical headings, each of which is followed by abstract numbers of documents dealing with that topic. Each subject heading has been put in a form and location believed to be most helpful to the user, and no attempt was made to adhere to a rigid formalism. Rather, each subject was handled in whatever manner appeared best for that particular case, even though inconsistencies in form often resulted.

Selected Symbols and Abbreviations

- k = $2\pi/\lambda$, the "wave number"
- ka = wave number times characteristic dimension of body
- λ = (free-space) wavelength
- σ = (radar backscattering) cross-section, unless otherwise indicated; in some cases, electrical conductivity
- σ° = (radar backscattering) cross-section per unit area of an extended target (also σ_o)
- γ = normalized (radar backscattering) cross-section, defined by $\sigma = \gamma A_i$, where A_i is projected incidence area normal to direction of propagation; alternatively $\gamma = \sigma^\circ/\sin\beta$, where β = depression (grazing) angle from horizontal
- ω = angular frequency = $2\pi f$
- $\rightarrow$ = vector quantity (arrow over symbol)
- $\rightrightarrows$ = tensor quantity (arrows over symbol)
- AGC = automatic gain control
- AI = airborne interception
- AMR = Atlantic Missile Range
- C_DA = aerodynamic drag coefficient times area
- dBm = decibels with respect to 1 milliwatt
- dBsm = decibels with respect to 1 m^2
- f = frequency
- GCI = ground-controlled interception
- HH = transmit horizontal polarization, receive horizontal polarization
- mi = statute miles
- MTI = moving-target indicator
- nmi = nautical miles
- PMR = Pacific Missile Range
- PPI = plan-position indicator
- RAM = radar-absorbing material
- RCS = radar cross-section
- R = rainfall rate; radar range
- RHI = range-height indicator
- SNR = signal-to-noise ratio
- VSWR = voltage standing-wave ratio
- VTOL = vertical take-off/landing
- VV = transmit vertical polarization, receive vertical polarization
- Z = radar-reflectivity factor (meteorological)
- Ed: = editor's note (as distinguished from a general note, Note:)

Frequency-Band Designations

VLF = 3 to 30 kc	P-band = 225 to 390 Mc	K_u-band = 12.4 to 18 Gc
LF = 30 to 300 kc	L-band = 390 to 1550 Mc	K_a-band = 26.5 to 40 Gc
MF = 300 to 3000 kc	S-band = 1.55 to 5.2 Gc	Q-band = 36 to 46 Gc
HF = 3 to 30 Mc	C-band = 3.9 to 6.2 Gc	V-band = 46 to 56 Gc
VHF = 30 to 300 Mc	X-band = 5.2 to 10.9 Gc	
UHF = 300 to 3000 Mc	K-band = 10.9 to 36 Gc	

Organization

The Subject Index has three levels: main headings, sub-headings, and sub-sub-headings, distinguished as follows. The main headings are ALL CAPS, double underlined; sub-headings are indented two spaces and are Cap and Lower Case, single underlined; sub-sub-headings are indented an additional two spaces and are Cap and Lower Case, not underlined.

Cross-References

Cross-references are used liberally throughout the Subject Index. These are of two basic types, as follows. (1) "See" References. Many headings are followed by the expression "See..." (or "See under...") and by no abstract numbers; they serve the sole purpose of directing the reader to the proper place to look for a subject. These may occur as entries at any level of heading. On the level of the alphabetical main headings, they are double underlined but are distinguished from actual headings by being Cap and Lower Case. On the level of a sub-heading or sub-sub-heading, they are distinguished only by having the "See" reference in place of the abstract numbers under a regular heading. (2) "See also" References. These are placed beneath actual headings which are followed by abstract numbers; they serve to point out related or supplementary headings. (See next section.)

Breakdown of Topics

Two approaches have been used in handling broad topics requiring extensive sub-division: (1) use of sub-headings and sub-sub-headings under a main heading; and (2) use of parallel main headings, possibly with sub-headings also.

(1) Where sub-headings are used, abstracts of documents having broad, general coverage are listed directly under the main heading, while those of more limited coverage are placed under the sub-headings. The reader interested in a sub-heading topic should also examine the abstracts listed under the main heading. Many of the general-coverage documents listed under a main heading may deal with the topics of the sub-headings, but they are not usually also listed under the sub-headings. In addition to general-coverage documents, the main heading may also be followed by abstract numbers of documents having limited coverage which could not be fitted into a sub-heading, as well as not-obtained documents whose precise coverage was unknown. The same caution applies to the relationship between sub-sub-headings and sub-headings--a reader interested in the sub-sub-heading should also check abstracts listed under the sub-heading.

(2) In many instances of complex subjects involving many abstracts, sub-topics have been broken out and listed separately as main headings, with a "See also" cross-reference from and to the broader heading. In such cases, only those documents having broader coverage are listed under the broader heading, while documents having narrower coverage will be listed only under the more specific heading. For example, although various forms of precipitation might have been listed as sub-headings under PRECIPITATION, they were, in fact brought out as parallel main headings (with "See also" cross-references): HAIL, RAIN, and SNOW. Under PRECIPITATION one should expect to find those documents whose material deals with or is applicable to all forms of precipitation (as well as miscellaneous documents which could not be given a more specific listing). Under HAIL one should expect to find documents dealing mainly with return from that form of precipitation only; these will not in general be

repeated under the more general heading. Thus, a reader desiring all documents relating to all forms of precipitation should examine the cross-referenced topics as well as the broad heading PRECIPITATION.

Form of Entries

Entries have been placed alphabetically where it was felt most readers would seek them. Thus, some entries such as CORNER REFLECTORS appear in "forward" order, while others such as PLATES, FLAT appear in "reverse" order. ("See" references are commonly used in such cases.) Many entries are names of radar targets, for instance, AIRCRAFT, AURORAS, CYLINDERS, HAIL. In these cases, it is implied that the objects are to be regarded as reflectors of radar radiation--some such expression as "Return from," "Scattering by," or "Reflection from" being understood. Occasionally a modifying term is added to avoid possible confusion.

Abstract Categorization

The abstract numbers following the headings are grouped into three numbered blocks, along with a fourth marked "J". The numbered blocks represent an attempt to evaluate the pertinence and importance of the documents, with respect to the particular subject heading concerned. Category 1 documents were judged to be substantially above average, based on such factors as pertinence to the particular subject topic, extent and comprehensiveness of treatment, apparent originality, importance and quality of work reported, and clarity of presentation. If any documents have been classed as Category 1 under a specific topic, they ordinarily are likely to be the best sources to investigate initially. Category 2 represents "average," and the intent has been to use this category for the bulk of the documents. Generally, Category 2 has been used for documents which were not obtained. Category 3 represents "minor interest" relative to the particular subject heading; these documents should mainly be of interest to someone desiring exhaustive coverage of the subject.

The judgments leading to each categorization were made at the time the abstracts were written and were reviewed in later editing. They are not, however, relative ratings resulting from direct comparison of all the documents listed under a given subject, and some headings may not show abstracts in but one or two categories. Although the categorizations are obviously subjective and imperfect, they should be helpful in guiding the reader to those reports best suited to his needs.

The fourth category (abstract numbers marked "J") comprises journal articles. Since these were usually reviewed only on the basis of an abstract and the article itself was not often seen, it was felt that they could not be usefully separated into the 1-2-3 categories.

Redundancy of Indexing

Considerable redundancy has been deliberately built into the Subject Index. Almost all documents are indexed under two or more headings, occasionally as many as 15 or 20. It is hoped that this redundancy will increase the user's chance of finding all the material about a subject of interest. Because of this redundancy, "browsing" the index is encouraged and may be helpful when an initial attempt to locate material is unsuccessful. Browsing of abstracts within the source group will sometimes also be helpful in locating material not specifically indexed.

SOURCE INDEX

SOURCE INDEX (CONT.)

SOURCE INDEX (CONT.)

SOURCE INDEX (CONT.)

SOURCE INDEX (CONT.)

SOURCE INDEX (CONT.)

SOURCE INDEX (CONT.)

SOURCE INDEX (CONT.)

SOURCE INDEX (CONT.)

SOURCE INDEX (CONT.)

SOURCE INDEX (CONT.)

SOURCE INDEX (CONT.)

SOURCE INDEX (CONT.)

(This page intentionally left blank.)

AUTHOR INDEX

AUTHOR INDEX (CONT.)

B

AUTHOR INDEX (CONT.)

AUTHOR INDEX (CONT.)

AUTHOR INDEX (CONT.)

AUTHOR INDEX (CONT.)

AUTHOR INDEX (CONT.)

AUTHOR INDEX (CONT.)

AUTHOR INDEX (CONT.)

AUTHOR INDEX (CONT.)

AUTHOR INDEX (CONT.)

AUTHOR INDEX (CONT.)

AUTHOR INDEX (CONT.)

E

AUTHOR INDEX (CONT.)

AUTHOR INDEX (CONT.)

AUTHOR INDEX (CONT.)

AUTHOR INDEX (CONT.)

AUTHOR INDEX (CONT.)

AUTHOR INDEX (CONT.)

AUTHOR INDEX (CONT.)

AUTHOR INDEX (CONT.)

AUTHOR INDEX (CONT.)

AUTHOR INDEX (CONT.)

AUTHOR INDEX (CONT.)

AUTHOR INDEX (CONT.)

AUTHOR INDEX (CONT.)

AUTHOR INDEX (CONT.)

AUTHOR INDEX (CONT.)

AUTHOR INDEX (CONT.)

AUTHOR INDEX (CONT.)

AUTHOR INDEX (CONT.)

AUTHOR INDEX (CONT.)

AUTHOR INDEX (CONT.)

AUTHOR INDEX (CONT.)

AUTHOR INDEX (CONT.)

AUTHOR INDEX (CONT.)

Q

R

AUTHOR INDEX (CONT.)

AUTHOR INDEX (CONT.)

AUTHOR INDEX (CONT.)

AUTHOR INDEX (CONT.)

AUTHOR INDEX (CONT.)

AUTHOR INDEX (CONT.)

AUTHOR INDEX (CONT.)

T

AUTHOR INDEX (CONT.)

AUTHOR INDEX (CONT.)

AUTHOR INDEX (CONT.)

AUTHOR INDEX (CONT.)

AUTHOR INDEX (CONT.)

AUTHOR INDEX (CONT.)

AUTHOR INDEX (CONT.)

SUBJECT INDEX

SUBJECT INDEX (CONT.)

SUBJECT INDEX (CONT.)

SUBJECT INDEX (CONT.)

SUBJECT INDEX (CONT.)

SUBJECT INDEX (CONT.)

SUBJECT INDEX (CONT.)

SUBJECT INDEX (CONT.)

SUBJECT INDEX (CONT.)

SUBJECT INDEX (CONT.)

SUBJECT INDEX (CONT.)

SUBJECT INDEX (CONT.)

SUBJECT INDEX (CONT.)

SUBJECT INDEX (CONT.)

SUBJECT INDEX (CONT.)

SUBJECT INDEX (CONT.)

SUBJECT INDEX (CONT.)

SUBJECT INDEX (CONT.)

SUBJECT INDEX (CONT.)

SUBJECT INDEX (CONT.)

SUBJECT INDEX (CONT.)

SUBJECT INDEX (CONT.)

SUBJECT INDEX (CONT.)

SUBJECT INDEX (CONT.)

SUBJECT INDEX (CONT.)

SUBJECT INDEX (CONT.)

SUBJECT INDEX (CONT.)

SUBJECT INDEX (CONT.)

SUBJECT INDEX (CONT.)

SUBJECT INDEX (CONT.)

SUBJECT INDEX (CONT.)

SUBJECT INDEX (CONT.)

SUBJECT INDEX (CONT.)

SUBJECT INDEX (CONT.)

SUBJECT INDEX (CONT.)

SUBJECT INDEX (CONT.)

SUBJECT INDEX (CONT.)

SUBJECT INDEX (CONT.)

SUBJECT INDEX (CONT.)

SUBJECT INDEX (CONT.)

SUBJECT INDEX (CONT.)

SUBJECT INDEX (CONT.)

SUBJECT INDEX (CONT.)

SUBJECT INDEX (CONT.)

SUBJECT INDEX (CONT.)

SUBJECT INDEX (CONT.)

SUBJECT INDEX (CONT.)

SUBJECT INDEX (CONT.)

SUBJECT INDEX (CONT.)

SUBJECT INDEX (CONT.)

SUBJECT INDEX (CONT.)

SUBJECT INDEX (CONT.)

SUBJECT INDEX (CONT.)

SUBJECT INDEX (CONT.)

SUBJECT INDEX (CONT.)

SUBJECT INDEX (CONT.)

SUBJECT INDEX (CONT.)

SUBJECT INDEX (CONT.)

SUBJECT INDEX (CONT.)

SUBJECT INDEX (CONT.)

AIRCRAFT CROSS-SECTION TABULATION

(Includes aircraft, tow targets, and self-powered targets; for additional listings, see page 267 of Volume VIII)

AIRCRAFT CROSS-SECTION TABULATION (CONT.)

MISSILE CROSS-SECTION TABULATION

(Includes return from missile bodies; for nosecones, decoys, and additional missile listings, see page 267 of Volume VIII)

MISSILE CROSS-SECTION TABULATION (CONT.)

Bull Goose (SM-73)
9482 10445 10446

Clam
10460

Corporal
9109 9674 10613 10635

Duck
9470

Falcon (GAR-1, AIM-4)
5072 9481 9746

Fuji (AAM-2)
9505

Green Quail (GAM-72)
9470 9473 10389 10450

Honest John
9540 10082 10084 10192 10197

Hound Dog (GAM-77)
9416 9502 9503 9504 10427
10698 10699

Jupiter
9215 9219 9674 10618 10635
10689

Lance
10079

Little John
9540 10081 10192 10218

Matador (TM-61)
9297 9472 10336

Minuteman (SM-80)
10415 10474 10618

MQM-58A
11155

Pershing
9540 10192 10395 11329

Polaris
9335 10318 10395 10618 11331

Rascal (GAM-63)
9491

Redstone
9674 10395 10635 10682

Robin
10395

Sergeant
10070 10071 10072 10073 10074
10075 10083 10192

Sidewinder (AIM-9)
5072

Skybolt (GAM-87)
10052

Slam
5810 5821

Snark (SM-62)
9419 9437 9478 9479 10428

Sparrow III (AIM-7)
9376 9746

Sputnik IV Rocket Body
9226

Terrier, BW-0, -1
11146

Thor (SM-75)
9029 9030 9215 9216 9217
9219 9327 9616 10395 10618

Titan (SM-68)
9029 9030 9216 9217 9222
9306 10297 10395 10618 10659
10682

Titan Second Stage
9029 9306 9327 9336 10657
10658 10659 10682 10141

V-2
10298 10531

WAC
10298

X-17
9615

DEPARTMENT OF THE ARMY
UNITED STATES ARMY ELECTRONICS COMMAND
FORT MONMOUTH, NEW JERSEY 07703

Distribution List For: Bibliography of Radar Reflection Characteristics
Contract No.: DA 36-039 AMC-03759(E)
ARPA Order No.: 672

(1) Office/Assistant Secretary Defense
(Research and Engineering)
ATTN: Technical Library, Rm 3E1065
Washington, D. C. 20301

(1) Defense Intelligence Agency
ATTN: DIARD
Washington, D. C. 20301

(5) Central Intelligence Agency
ATTN: OSI/RD [Vol. X]
OCR/DD/Publications [Vols. VII-IX]
Washington, D. C. 20505

(1) U.S. Coast Guard Headquarters
[Vol. VII only]
Office of Engineering
1300 E Street, N.W.
Washington, D. C. 20226

(1) Environmental Science Services
Administration & NBS [Vol. VII only]
Boulder Laboratories
ATTN: Library 580:52/EB
Boulder, Colorado 80302

(1) Federal Aviation Agency
Information Retrieval Br. HQ-630
800 Independence Ave., S.W.
Washington, D. C. 20553

(1) National Aeronautics & Space Admin.
Electronics Research Center
ATTN: AS/Mail & Records
575 Technology Square
Cambridge, Massachusetts 02139

(2) NASA [1 ea. Vols. IX,X]
Langley Research Center
ATTN: Associate Director
Langley Station
Hampton, Virginia 23365

(13) NASA Scientific and Technical
Information Facility
ATTN: Acquisitions Branch (S-AK/DL)
P. O. Box 33
College Park, Maryland 20740

(1) Director
National Security Agency
ATTN: C3/TDL
Fort George G. Meade, Maryland 20755

(1) Office, Chief of Research & Development
Department of the Army
ATTN: Stinfo Library, 3D442
Washington, D. C. 20310

(1) U.S. Army Aviation Materiel Labs
ATTN: Security Officer
Fort Eustis, Virginia 23604

(1) Chief, MEWTA
ATTN: AMSEL-WL-MD (Mr. Gill)
White Sands Missile Range
New Mexico 88002

(1) Commanding General
ATTN: STEWS-WS-VT
White Sands Missile Range
New Mexico 88002

(2) Commanding Officer
U.S. Army Ballistic Research Laboratories
ATTN: AMXBR-BB (V. W. Richard)
Aberdeen Proving Ground, Maryland 21005

(1) Commanding Officer
U.S. Army Ballistic Research Laboratories
ATTN: AMXBR-BB (K. A. Richer)
Aberdeen Proving Ground, Maryland 21005

(1) Commanding Officer
U.S. Army Limited War Laboratory
ATTN: Research Analysis Branch
Aberdeen Proving Ground, Maryland 21005

(1) President
U.S. Army Artillery Board
ATTN: STEBA-GD
Fort Sill, Oklahoma 73503

(2) Chief of Research & Development
Department of the Army
Washington, D. C. 20315

(1) Office/Chief of Comm-Electronics
Department of the Army
ATTN: CCEES-3
Washington, D. C. 20315

(2) Commanding General
U.S. Army Materiel Command
ATTN: R&D Directorate
Washington, D. C. 20315

(1) U.S. Army Mobility Command
ATTN: AMSMO-RD-D
Warren, Michigan 48090

(3) Redstone Scientific Information Center
ATTN: Chief, Document Section
U.S. Army Missile Command
Redstone Arsenal, Alabama 35809

(1) Headquarters
U.S. Army Weapons Command
ATTN: AMSWE-RDR
Rock Island, Illinois 61201

(4) Commanding Officer
Aberdeen Proving Ground
ATTN: (3) Technical Library, Bldg 313
(1) Ballistic Meas. Lab.,
Mr. W. Berning
Aberdeen Proving Ground, Maryland 21005

(1) Commanding General
U.S. Army Combat Development Command
ATTN: CDCMR-E
Fort Belvoir, Virginia 22060

(3) Commanding Officer
U.S. Army Combat Developments Command
Communications-Electronics Agency
Fort Monmouth, New Jersey 07703

(1) Commanding Officer
U.S. Army Security Agency
Combat Development Activity
Arlington Hall Station
Arlington, Virginia 22212

(3) U.S. Army Security Agency
ATTN: OAC of S, Dev (CDA)
Arlington Hall Station
Arlington, Virginia 22212

(1) Technical Support Directorate
ATTN: Technical Library, Bldg 3330
Edgewood Arsenal
Maryland 21010

(1) Commanding General
U.S. Army Missile Command
ATTN: Mr. Wm. C. Pittman (AMSI-RES)
Redstone Arsenal, Alabama 35809

(4) Harry Diamond Laboratories
ATTN: (1) Mr. Jas. S. Shrede
(3) Library, Rm 200, Bldg 92
Connecticut Avenue & Van Ness Street
Washington, D. C. 20438

(2) Commanding Officer
U.S. Army Engineer R&D Labs
ATTN: STINFO Branch
Fort Belvoir, Virginia 22060

(1) Commandant
U.S. Army Air Defense School
ATTN: C&S Dept, MSL SCI Div
Fort Bliss, Texas 79916

(1) Commanding General
U.S. Army Electronic Proving Ground
ATTN: Technical Information Center
Fort Huachuca, Arizona 85613

(1) Assistant Secretary of the Army (R&D)
ATTN: Deputy Assistant for Army (R&D)
Department of the Army
Washington, D. C. 20315

(1) Assistant Secretary of the Army (R&D)
ATTN: Assistant for Research
Department of the Army
Washington, D. C. 20315

(4) Commanding Officer
Frankford Arsenal
ATTN: (1) SMUFA-N2000
(1) SMUFA-N4000
(1) SMUFA-N5000
(1) SMUFA-N5100
Philadelphia, Pa. 19137

(1) CG, U.S. Army Electronics Command
ATTN: AMSEL-MR
225 South 18th Street
Philadelphia, Pa. 19103

(1) Chief, Mountain View Office
Electronic Warfare Lab-USAECOM
P.O. Box 205
Mountain View, California 94042

(1) Chief
Missile Electronic Warfare Tech. Area
EW Lab, USAECOM
White Sands Missile Range
New Mexico 88002

(1) USAECOM Liaison Officer
MIT, Bldg 26, Rm 131
77 Massachusetts Avenue
Cambridge, Massachusetts 02139

(1) USAECOM Liaison Officer
Aeronautical Systems Division
ATTN: ASDL-9
Wright-Patterson AFB, Ohio 45433

(1) USAECOM Liaison Officer
Rome Air Development Center
ATTN: EMPL
Griffiss AFB New York 13440

(1) USAECOM Liaison Office
U.S. Army Electronic Proving Ground
Fort Huachuca, Arizona 85613

(1) Director, Night Vision Laboratory
U.S. Army Electronics Command
ATTN: Systems Dev. Tech. Area,
AMSEL-HL-NVSD
Fort Belvoir, Virginia 22060

(3) Director Institute/Exploratory Research
U.S. Army Electronics Command
ATTN: (1) AMSEL-XL-D
(1) AMSEL-XL-C
(1) AMSEL-XL-S
Fort Monmouth, New Jersey 07703

(2) Director, Interference Reduction Branch
U.S. Army Electronics Command
ATTN: (1) AMSEL-RD-GFA
(1) AMSEL-RD-GFR
Fort Monmouth, New Jersey 07703

(1) Director, Avionics Laboratory
U.S. Army Electronics Command
ATTN: Mr. T. E. Maloney (AMSEL-VL-E)
Fort Monmouth, New Jersey 07703

(4) Director, CSTA Laboratory
U.S. Army Electronics Laboratory
ATTN: (3) AMSEL-HL-CT-R
(1) AMSEL-HL-CT-P
Fort Monmouth, New Jersey 07703

(7) Commanding General
U.S. Army Electronics Command
ATTN: (1) AMSEL-CB
(1) AMSEL-EW
(1) AMSEL-10-T
(1) AMSEL-RD-MAT
(1) AMSEL-WL-D
(1) AMSEL-KL-D
(1) AMSEL-VL-D
Fort Monmouth, New Jersey 07703

(1) Commander
Operational Test and Evaluation Force
Norfolk, Virginia 23511

(2) Commanding Officer (Tech. Lib.)
U.S. Naval Air Development Center
Johnsville, Warminster, Pa. 18974

(1) Commander, Naval Air Test Center
ATTN: M. E. Riegel
Weapons Systems Test Division
NATC, Patuxent River, Maryland 20670

(1) Commander
U.S. Naval Missile Center
ATTN: Code 5632 (Technical Library)
Point Mugu, California 93041

(1) Commanding Officer
U.S. Naval Ordnance Laboratory
ATTN: Library
Corona, California 91720

(1) Superintendent
U.S. Naval Postgraduate School
ATTN: Code 0384
Monterey, California 93940

(1) Commanding Officer & Director
U.S. Naval Radiological Defense Lab.
ATTN: Code 222A
San Francisco, California 94135

(1) U.S. Naval Scientific & Technical
Intelligence Center
ATTN: STIC-1E
Naval Observatory, Bldg 52
Washington, D. C. 20390

(1) Commanding Officer & Director
[no Vol. X]
Naval Training Device Center
ATTN: Technical Library
Orlando, Florida 32813

(1) U.S. Naval Weapons Laboratory
ATTN: WDA (Technical Library)
Dahlgren, Virginia 22448

(1) Commanding Officer and Director
U.S. Navy Electronics Laboratory
ATTN: Library
San Diego, California 92152

(10) Director
U.S. Naval Research Laboratory
ATTN: (2) Code 2027
(1) Code 5220
(1) Code 5270
(1) Code 5310
(1) Code 5320
(1) Code 5330
(2) Code 5340
(1) Code 5360
Washington, D. C. 20390

(1) Naval Air Systems Command
ATTN: AIR-604A (Library)
18th and Constitution Avenue, N.W.
Washington, D. C. 20360

(1) Naval Ships Systems Command
ATTN: Code 6312 (Technical Library)
Main Navy Building, Rm 1528
Washington, D. C. 20360

(1) Naval Ships Systems Command
ATTN: Code 6454
Department of the Navy
Washington, D. C. 20360

(2) Commander
U.S. Naval Ordnance Laboratory
ATTN: (1) Technical Library
(1) Mr. E. H. Jackson, Jr.
White Oak, Silver Spring, Md. 20910

(2) Director, Naval Ordnance Test Statio·.
ATTN: (1) Code 4022
(1) Code 753 (Technical Library)
China Lake, California 93557

(1) Commanding Officer
Naval Electronics Systems Command
ATTN: Code 0513234
5805 Leesburg Pike
Bailey Crossroads, Virginia 22041

(1) Headquarters, SAC (OAI)
Offutt AFB, Nebraska 68113

(1) Ballistic Systems Division (BSOMS)
Norton AFB, California 92409

(1) Systems Engineering Group (RTD)
ATTN: SEPIR
Wright-Patterson AFB, Ohio 45433

(3) Foreign Technology Division
Air Force Systems Command
ATTN: TDBTL, Library
Wright-Patterson AFB, Ohio 45433

(4) Air Force Avionics Laboratory
ATTN: (2) AVWE (Mr. W. F. Bahret)
(1) AVWW (Mr. Portune)
(1) AVRS
Wright-Patterson AFB, Ohio 45433

(1) Air Force Cambridge Research Laboratories
ATTN: CRN (Dr. Hollingsworth)
L. G. Hanscom Field
Bedford, Massachusetts 01730

(1) Air Force Weapons Laboratory
Electronics Branch (WLDE)
Kirtland AFB, New Mexico 87117

(1) Director
Air University Library
ATTN: AUL3T-66-247
Maxwell AFB, Alabama 36112

(3) Rome Air Development Center
ATTN: (1) EMTLD (Documents Library)
(1) EMAS (Mr. D. M. Montana)
(1) EMAS (Mr. L. C. Gratch)
Griffiss AFB, New York 13440

(3) Electronic Systems Division
ATTN: (2) ESTI
(1) ESLTS
L. G. Hanscom Field
Bedford, Massachusetts 01730

(1) Air Proving Ground Center
ATTN: PGBPS-12
Eglin AFB, Florida 32542

(1) Headquarters R&T Division
ATTN: RTTC
Bolling AFB, D. C. 20332

(1) Air Force Systems Command
STLO (RTSND)
Naval Air Development Center
Johnsville, Warminster
Pennsylvania 18974

(1) The Aerospace Corporation
ATTN: Library Acquisitions Group
P. O. Box 95085
Los Angeles, California 90045

(1) The Aerospace Corporation
ATTN: Technical Library
P. O. Box 1308
San Bernardino, California 92402

(1) Battelle Memorial Institute
ATTN: BDIAC
505 King Avenue
Columbus, Ohio 43201

(1) Center for Naval Analyses
1401 Wilson Boulevard
Arlington, Virginia 22209

(1) General Research Corporation
P.O. Box 3587
Santa Barbara, California 93105

(1) Institute for Defense Analyses
ATTN: Document Control
400 Army-Navy Drive
Arlington, Virginia 22202

(2) The Mitre Corporation
ATTN: Library
P.O. Box 208
Bedford, Massachusetts 01730

(1) Director, USAF Project RAND
Via: Air Force Liaison Office
The RAND Corporation
ATTN: Library-D
1700 Main Street
Santa Monica, California 90406

(1) TRW Systems
ATTN: Technical Library
7001 North Atlantic Avenue
Cape Canaveral, Florida 32920

(1) Jet Propulsion Laboratory
California Institute of Technology
ATTN: Library (TDS)
4800 Oak Grove Drive
Pasadena, California 91103

(2) Columbia University Electronics
Research Laboratories
632 West 125th Street
New York, New York 10027

(1) Cornell Aeronautical Lab., Inc. [no Vol.X]
ATTN: J. P. Desmond, Head Librarian
4455 Genesee Street
Buffalo, New York 14221

(5) Georgia Institute of Technology
Engineering Experiment Station
ATTN: Research Security Coordinator
Atlanta, Georgia 30332

(1) Carlyle Barton Laboratory
The Johns Hopkins University
ATTN: Librarian
34th and Charles Sts.
Baltimore, Maryland 21218

(1) The Johns Hopkins University
Applied Physics Laboratory
ATTN: Document Librarian
8621 Georgia Avenue
Silver Spring, Maryland 20910

(1) Massachusetts Institute of Technology
ATTN: Miss P. Meserlian, Librarian
Bldg. 35-315
Electronic Systems Laboratory
Cambridge, Massachusetts 02139

(3) Lincoln Laboratory, M.I.T.
ATTN: Library A-082
P.O. Box 73
Lexington, Massachusetts 02173

(1) The Ohio State University Research
Foundation
ATTN: Security Officer
1314 Kinnear Road
Columbus, Ohio 43212

(1) Stanford Electronics Laboratories
Stanford University
ATTN: Research Security Administrator
Stanford, California 94305

(2) Stanford Research Institute
ATTN: Classified Documents Services
Menlo Park, California 94025

(1) Syracuse University Research Corp.
ATTN: Dr. Robert N. Lothes
P.O. Box 26, University Station
Syracuse, New York 13210

(2) Illinois State Water Survey [1 ea Vols.
IX, X]
Security Officer
331 Student Services Bldg.
ATTN: Glenn E. Stout
610 East John Street
Champaign, Illinois 61820

(1) Center for Research, Inc. CRES
ATTN: Security Officer
University of Kansas
Lawrence, Kansas 66044

(1) Radar Meteorological Laboratory
ATTN: Homer W. Hiser, Head
P.O. Box 8003
University of Miami
Coral Gables, Florida 33124

(5) The University of Michigan
[1 ea Vols. VIII-X]
Research Security Office
ATTN: R. E. Hiatt, Head
Radiation Laboratory
P.O. Box 622
Ann Arbor, Michigan 48107

(3) The University of Michigan
Institute of Science & Technology
ATTN: (1) Technical Documents Service
(2) IRIA Library
P. O. Box 618
Ann Arbor, Michigan 48107

(1) University of Houston
Electrical Engineering Department
ATTN: Dr. H. S. Hayre
Houston, Texas 77004

(1) The University of Texas
Defense Research Laboratory
P.O. Box 8029
Austin, Texas 78712

(1) Airborne Instruments Laboratory
ATTN: A. Zajac, CDC
Comac Road
Deer Park, L.I., New York 11729

(1) Airtronics, Inc., Tech Library
ATTN: Mr. Aaron S. Dann
Dulles International Airport
P. O. Box 17186
Washington, D. C. 20041

(1) Autonetics
ATTN: Main Technical Library
D/503, B/202
3370 Miraloma Avenue
Anaheim, California 92803

(1) Avco Missile Systems Division
ATTN: Maurice F. Rahilly
Chief, Research Library
201 Lowell Street
Wilmington, Massachusetts 01887

(1) Bell Aerosystems Company
ATTN: Security Officer
P.O. Box 628
Fort Huachuca, Arizona 85706

(1) Bell Helicopter Company
Technical Library
ATTN: Document Control
P.O. Box 482
Fort Worth, Texas 76101

(1) The Bendix Corporation [no Vol. X]
Mishawaka Division
ATTN: Technical Library
400 South Beiger Street
Mishawaka, Indiana 46544

(1) The Bendix Corporation
Bendix Radio Division
East Joppa Road
Towson, Maryland 21204

(1) Bjorksten Research Laboratories, Inc.
P.O. Box 265
Madison, Wisconsin 53701

(1) The Boeing Company
Wichita Division
ATTN: Library
Wichita, Kansas 67210

(1) The Boeing Company
Aerospace Group
ATTN: Ruth E. Peerenboom
Technical Library
Process Supervisor
P.O. Box 3707
Seattle, Washington 98124

(1) Norbert N. Bojarski
16 Circle Drive
Moorestown, New Jersey 08057

(1) Brown Engineering Company
ATTN: Technical Library
300 Sparkman Drive
Huntsville, Alabama 35805

(1) Electromagnetic Research Corporation
5001 College Avenue
College Park, Maryland 20740

(1) Electro-Optical Systems, Inc.
ATTN: Library
300 N. Halstead St.
Pasadena, California 91107

(1) Emerson & Cuming, Inc.
ATTN: Dr. Elery F. Buckley
869 Washington Street
Canton, Massachusetts 02021

(1) Fairchild Hiller Corporation
Electronics & Information Systems Div.
ATTN: Technical Library
5006 Jackson Street
Bladensburg, Maryland 20710

(1) Fairchild Hiller Corporation
Aircraft Missiles Division
ATTN: Engineering Library
Hagerstown, Maryland 21740

(1) General Atronics Corporation
ATTN: Librarian
1200 E. Mermaid Lane
Philadelphia, Pennsylvania 19118

(1) General Dynamics/Electronics Division
San Diego Operations
ATTN: Document Control Station
Number 69, MZ 7-26
3090 Pacific Highway
P.O. Box 127
San Diego, California 92112

(1) General Electric Company
ATTN: Catherine Lukens, Librarian
Electronics Lab., Building 9
Electronics Park
Syracuse, New York 13200

(1) General Electric Company
ATTN: Mrs. Dorothy O'Connor
Rm G7-Bldg. 1, Farrell Road Plant
Syracuse, New York 13200

(1) General Electric Company
Missile/Space Division
ATTN: L. I. Chasen, Mgr/MSD Libr.
P.O. Box 8555
Philadelphia, Pennsylvania 19101

(1) General Electric-TEMPO
ATTN: Warren W. Chan
816 State Street
Santa Barbara, California 93102

(1) General Motors Corporation
GM Defense Research Laboratories
6767 Hollister Avenue
Goleta, California 93017

(2) General Precision Inc.
GPL Div., Aerospace Group
ATTN: Ann Lawrence, Chief Librarian
63 Bedford Road
Pleasantville, New York 10570

(1) Goodyear Aerospace Corporation
ATTN: Library
1210 Massillon Road
Akron, Ohio 44315

(1) Grumman Aircraft Engineering Corp.
ATTN: Engineering Library
Plant 25
Bethpage, New York 11714

(1) Hazeltine Corporation
Hazeltine Electronics Division
ATTN: Tech. Documents Custodian
Little Neck, New York 11362

(1) HRB-Singer, Inc.
ATTN: A. J. Visnovsky, Manager
Technical Information Center
P.O. Box 60, Science Park
State College, Pennsylvania 16801

(3) Hughes Aircraft Company
Company Technical Document Center
ATTN: B. W. Campbell, Supervisor
Bldg. 6, M.S. E-110
Centinela at Teale Street
Culver City, California 90232

(1) ITT Electro-Physics Laboratories, Inc.
3355 52nd Avenue
Hyattsville, Maryland 20781

(1) ITT Gilfillan, Inc.
ATTN: Lydia Hoyle,
Master Control Station #1
1815 Venice Blvd.
Los Angeles, California 90006

(1) LFE - Electronics Division
ATTN: Security Officer
1075 Commonwealth Avenue
Boston, Massachusetts 02215

(1) Leesona Corporation
Leesona Moos Laboratories Division
Community Drive & Pond Hill Road
Lake Success, Long Island, New York 11021

(1) Lockheed-California Company
ATTN: Central Library
2555 North Hollywood Way
Burbank, California 91503

(1) Lockheed Electronics Company
ATTN: John F. Moore
U.S. Highway 22
Plainfield, New Jersey 07060

(2) Lockheed-Georgia Company [1 ea Vols. VIII-X]
ATTN: C. K. Bauer
D/72-34, Z-26
Marietta, Georgia 30061

(4) Lockheed Missiles and Space Company
Palo Alto Library
Technical Information Center (50-14)
3251 Hanover Street
Palo Alto, California 94304

(1) Martin Company
ATTN: Engineering Library
P.O. Box 5837 (MP-30)
Orlando, Florida 32805

(1) Martin Company
Science-Technology Library, Mail 398
ATTN: C. O. Strickler,
Chief, Libraries
Baltimore, Maryland 21203

(3) McDonnell Aircraft Corporation [1 ea. Vols. IX, X]
ATTN: McDonnell Library, Dept. 218
P. O. Box 516
St. Louis, Missouri 63166

(2) Melpar, Inc.
ATTN: Security Office
7700 Arlington Blvd.
Falls Church, Virginia 22000

(1) Micronetics Division
Teledyne Systems Company
ATTN: Security Officer
P.O. Box 20396
San Diego, California 92120

(1) North American Aviation, Inc. [no Vol. X]
Engineering Data Services
4300 E. Fifth Avenue
Columbus, Ohio 43216

(1) North American Aviation, Inc.
ATTN: LAD Library, Dept. 56
International Airport
Los Angeles, California 90009

(1) North American Aviation, Inc.
ATTN: TIC D/995-471
2000 North Memorial Drive
Tulsa, Oklahoma 74151

(1) Philco Corporation [no Vol. X]
ATTN: Library MS 543
3825 Fabian Way
Palo Alto, California 94303

(2) E. H. Plesset Associates, Inc.
ATTN: Security Office
2444 Wilshire Blvd.
Santa Monica, California 90403

(1) Radiation Incorporated
Box 37
Melbourne, Florida 32902

(1) Radio Corporation of America
Aerospace Systems Division
P.O. Box 588
Burlington, Massachusetts 01801

(1) Radio Corporation of America
Defense Electronic Products
Missile & Surface Radar Division
Moorestown, New Jersey 08057

(1) Radio Corporation of America
ATTN: Mr. Stanley Stein
RCA Laboratories
Princeton, New Jersey 08540

(1) Raytheon Company
ATTN: Library
Bedford, Massachusetts 01730

(1) Revere Copper & Brass Inc.
Foil Division
115 Sutton Street
Brooklyn, New York 11222

(2) Sandia Corporation [1 ea Vols. VIII-X]
ATTN: Information Distribution Division
P.O. Box 5800
Sandia Base
Albuquerque, New Mexico 87115

(1) Smyth Research Associates
3555 Aero Court
San Diego, California 92123

(1) Space-General Corp. [no Vol. X]
ATTN: Technical Library [Vols. VII-VIII]
Class. Doc. Control [Vol. IX]
9200 E. Flair Drive
El Monte, California 91734

(1) Sylvania Electronic Systems
Applied Research Laboratory Library
ATTN: E. McLaughlin
40 Sylvan Road
Waltham, Massachusetts 02154

(1) Sylvania Electronic Systems-WO
Electronic Defense Laboratories
ATTN: Tech. Doc. Center/P. Slater
P.O. Box 205
Mountain View, California 94040

(1) TRG, Incorporated [Vol. VII only]
130 Constitution Drive
Menlo Park, California 94025

(1) TRACOR, Inc.
ATTN: Document Control
6500 Tracor Lane
Austin, Texas 78721

(1) Vitro Laboratories
ATTN: Library, Room V-2113
14,000 Georgia Avenue
Silver Spring, Maryland 20910

(1) Westinghouse Electric Corp. [no Vol. X]
Defense & Space Center
ATTN: Technical Information Center
Friendship International Airport
Baltimore, Maryland 21203

(2) Director
Advanced Research Projects Agency
ATTN: Mr. Morris I. Witow
The Pentagon
Washington, D. C. 20301

(3)* Director
Advanced Research Projects Agency
ATTN: Mr. Fred A. Koether
The Pentagon
Washington, D. C. 20301

(**) Defense Documentation Center
ATTN: DDC-IRS
Cameron Station (Bldg 5)
Alexandria, Virginia 22314

*23 additional copies held at Georgia Tech pending review for distribution.

**Copies as follows: Vol. VII, 201; Vol. VIII, 210; Vol. IX, 214; Vol. X, 221.

This contract is supervised by the Radar Technical Area, Combat Surveillance and Target Acquisition Laboratory, U. S. Army Electronics Laboratory, Fort Monmouth, New Jersey 07703. Contracting Officer's Technical Representatives are: Mr. Ransom F. Reed and Dr. Leonard Hatkin; telephone - Area 201, 596-1655.

Unclassified
Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY *(Corporate author)* Engineering Experiment Station Georgia Institute of Technology Atlanta, Georgia 30332	2a. REPORT SECURITY CLASSIFICATION Unclassified 2b. GROUP N/A

3. REPORT TITLE

A BIBLIOGRAPHY OF RADAR REFLECTION CHARACTERISTICS, Volume VII

4. DESCRIPTIVE NOTES *(Type of report and inclusive dates)*
Final Report

5. AUTHOR(S) *(First name, middle initial, last name)*

Corriher, Henry A., Jr. and Pyron, Berry O.; with Jenkins, Herndon H.; Eaves, Jerry L.; Zimmer, Robert P.; and others.

6. REPORT DATE 14 April 1967	7a. TOTAL NO. OF PAGES x + 617	7b. NO. OF REFS 3100

8a. CONTRACT OR GRANT NO. DA 36-039 AMC-03759(E) b. PROJECT NO. 1Z6-20901-A-188-02 c. ARPA Order No. 672 d.	9a. ORIGINATOR'S REPORT NUMBER(S) Final Report on Project A-755 9b. OTHER REPORT NO(S) *(Any other numbers that may be assigned this report)* Technical Report ECOM-03759-F, Part 1 of 4

10. DISTRIBUTION STATEMENT This document is subject to special export controls and each transmittal to foreign governments or foreign nationals may be made only with prior approval of Commanding General, U. S. Army Electronics Command, ATTN: AMSEL-HL-CT-R, Fort Monmouth, New Jersey 07703.

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY U. S. Army Electronics Command AMSEL-HL-CT-R Fort Monmouth, N. J. 07703

13. ABSTRACT

This is the seventh in a series of volumes prepared by Georgia Tech as a comprehensive guide to the literature on radar reflection characteristics. Four volumes were prepared under the present program and cover the following approximate numbers of reports, papers, journal articles, etc.: Volume VII-Unclassified (1400 reports, 1700 journal articles); Volume VIII-Confidential (1100 reports); Volume IX-Secret (1000 reports); and Volume X-Secret-Restricted Data (500 reports). Volume VII also contains Source, Author, and Subject Indices, and a Guide to Use of the Bibliography. The six previous volumes are available from DDC. Information is included on all forms of radar targets, both artificial and natural. Coverage also includes camouflage and absorbers, cross-section prediction, and measurement techniques and equipment. A considerable amount of material on scattering and diffraction is also included, as are abstracts on certain aspects of propagation. Information on radar systems, per se, is not included. Coverage is primarily for documents issued from 1957 through 1964, but a few earlier documents are also abstracted.

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Radar Reflectivity						
Radar Targets						
Radar Reflectors						
Radar Cross-Sections						
Radar Echo Areas						
Radar Confusion Reflectors						
Radar Clutter						
Ground and Sea Return						
Antiradar Coatings						
Electromagnetic Propagation						
Electromagnetic Scattering						
Scattering						
Diffraction						
Bibliography						
Abstracts						